RL/REG-98-01
Revision 0

DOE Regulatory Unit Evaluation Report of the BNFL Inc. Safety Requirements Document

March 1998

Office of Radiological, Nuclear, and Process
Safety Regulation of TWRS Privatization Contractors

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PREFACE

The Department of Energy's (DOE) Richland Operations Office (RL) issued the TWRS Privatization Request for Proposal (RFP) for Hanford Tank Waste Remediation System (TWRS) Privatization in February 1996. Offers were requested to submit proposals for the initial processing of the tank waste at Hanford. Some of this radioactive waste has been stored in large underground storage tanks at the Hanford Site since 1944. Currently, approximately 56 million gallons of waste containing approximately 240,000 metric tons of processed chemicals and 250 megacuries of radionuclides are being stored in 177 tanks. These caustic wastes are in the form of liquids, slurries, saltcakes, and sludges. The wastes stored in the tanks are defined as high-level radioactive waste (10 CFR Part 50, Appendix F) and hazardous waste (Resource Conservation and Recovery Act).

Under the privatization concept, DOE will purchase waste treatment services from a contractor-owned, contractor-operated facility under a fixed-price contract. DOE will provide the waste feedstock to be processed but maintain ownership of the waste. The contractor must: a) provide private financing; b) design the equipment and facility; c) apply for and receive required permits and licenses; d) construct the facility and bring it on-line; e) operate the facility to treat the waste according to DOE specifications; and f) deactivate the facility.

The TWRS Privatization Program is divided into two phases, Phase I and Phase II. Phase I is a proof-of-concept/commercial demonstration-scale effort the objectives of which are to a) demonstrate the technical and business viability of using privatized contractors to treat Hanford tank waste; b) define and maintain adequate levels of radiological, nuclear, process, and occupational safety; c) maintain environmental protection and compliance; and d) substantially reduce life-cycle costs and time required to treat the tank waste. The Phase I effort consists of two parts: Part A and Part B.

Part A consists of a twenty-month development period to establish appropriate and necessary technical, operational, regulatory, business, and financial elements. This will include identification by the TWRS Privatization Contractors and approval by DOE of appropriate safety standards, formulation by the Contractors and approval by DOE of integrated safety management plans, and preparation by the Contractors and evaluation by DOE of initial safety assessments. Of the twenty-month period, sixteen months will be used by the Contractors to develop the Part-A products and four months will be used by DOE to evaluate the products.

Part B consists of a demonstration period to provide tank waste treatment services by one or more of the TWRS Privatization Contractors who successfully complete Part A. Demonstration will address a range of wastes representative of those in the Hanford tanks. Part B will be 10 to 14 years in duration. Within Part B, wastes will be processed during a 5- to 9-year period and will result in treatment of 6 to 13 percent of the Hanford tank waste.

Phase II will be a full-scale production phase in which the remaining tank waste will be processed on a schedule that will accomplish removal from all single-shell tanks by the year 2018. The objectives of Phase II are to a) implement the lessons learned from Phase I; and b) process all tank waste into forms suitable for final disposal.

A key element of the TWRS Privatization Contracts is DOE regulation of radiological, nuclear, and process safety through the establishment of a specifically chartered, dedicated Regulatory Unit (RU) at RL. This regulation by the RU is authorized by the document entitled Policy for Radiological, Nuclear, and Process Safety Regulation of TWRS Privatization Contractors (referred to as the Policy) is implemented through the document entitled Memorandum of Agreement for the Execution of Radiological, Nuclear, and Process Safety Regulation of the TWRS Privatization Contractors (referred to as the MOA). The Policy is signed by the Under Secretary of Energy; the Manager, RL; the Assistant Secretary for Environment, Safety and Health (ASEH); and the Assistant Secretary for Environmental Management (ASEM). The MOA is signed by the Manager, RL; the ASEH; and the ASEM. The nature and characteristics of this regulation are also specified in these documents. The MOA details certain interactions among RL, the ASEH, and the ASEM as well as their respective roles and responsibilities for implementation of this regulation.

The authority of the RU to regulate the TWRS Privatization Contractors is derived solely from the terms of the TWRS Privatization Contracts. Its authority to regulate the Contractors on behalf of DOE is derived from the Policy. The nature and scope of this special regulation (in the sense that it is based on terms of a contract rather than formal regulations) is delineated in the MOA, the TWRS Privatization Contracts, and the four documents (listed below), which are incorporated into the Contracts. This special regulation by the RU in no way replaces any legally established external regulatory authority to regulate in accordance with their duly promulgated regulations nor relieves the Contractors from any obligations to comply with such regulations or to be subject to the enforcement practices contained therein.

The Policy, the MOA, the TWRS Privatization Contracts, and the four documents incorporated in the Contracts define the essential elements of the regulatory program, which will be executed by the RU and to which the TWRS Privatization Contractors must conform. The four documents incorporated in the Contracts (and also incorporated in the MOA) are

Concept of the DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors, DOE/RL-96-0005,

DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors, DOE/RL-96-0003,

Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors, DOE/RL-96-0006, and

Process for Establishing a Set of Radiological, Nuclear, and Process Safety Standards and Requirements for TWRS Privatization, DOE/RL-96-0004.

In the execution of the regulatory program, the RU will consider not only the relevant approaches and practices of DOE but also those of the Nuclear Regulatory Commission (NRC). The Policy states that

"It is DOE's policy that TWRS privatized contractor activities be regulated in a manner that assures adequate radiological, nuclear, and process safety by application of regulatory concepts and principles consistent with those of the Nuclear Regulatory Commission."

To this end, the RU will interact with the NRC (under the provisions of a memorandum of understanding with the NRC) during development of regulatory guidance and during execution of the regulatory program to ensure implementation of this policy.

All documents issued by the Office of Radiological, Nuclear, and Process Safety Regulation of TWRS Privatization Contractors are available to the public through the DOE/RL Public Reading Room at the Washington State University, Tri-Cities Campus, 100 Sprout Road, Richland, Washington.

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Executive Summary

This Evaluation Report documents the evaluation of the BNFL Inc. *Safety Requirements Document*, BNFL-5193-SRD-01, that was submitted to the U.S. Department of Energy, Richland Operations Office (RL), Office of Radiological, Nuclear, and Process Safety Regulation of TWRS Privatization Contractors (Regulatory Unit ([RU]) on September 26, 1997. The Safety Requirements Document (SRD) is one part of the BNFL Standards Approval (SA) Package identified by Table S4-1 of the U.S. Department of Energy (DOE) Contract with BNFL Inc. (DE-AC06-96RL13308).

The DOE regulatory approach for TWRS Privatization (TWRS-P) activities requires that the Contractor take an active role in identifying and recommending the standards and requirements that will be used to achieve adequate safety for its specific activities. These standards and requirements, and the standards-based integrated safety management program that will be employed to meet them, are documented in the SA Package. With submittal of the BNFL SA Package, the RU began the first of six major regulatory actions for the BNFL proposal (i.e., Standards Approval). The purpose of the Standards Approval regulatory action is to approve the Contractor-recommended set of radiological, nuclear, and process safety standards and requirements documented in its SRD and to approve the Contractor's standards-based integrated safety management program documented in its Integrated Safety Management Plan (ISMP). These documents serve as the basis for the Contractor's subsequent safety-related activities.

This Evaluation Report documents the review of the BNFL SRD that was performed using *Guidance for the Review of TWRS Privatization Contractor Safety Requirements Document Submittal Package*, RL/REG-97-08. The Standards Approval regulatory action is being conducted in accordance with *DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors*, DOE/RL-96-0003. The review was planned and executed in accordance with the *BNFL Inc. Standards Approval Review Planning Handbook*, RL/REG-97-05. The reviewers systematically evaluated the SRD and formulated a set of detailed conclusions that support the RU Regulatory Official's (RO) determination of whether the SRD should be approved.

The review was conducted in two steps:

- A 7-day acceptability review to determine whether the SA Package (and the SRD as a component) is acceptable for detailed review.
- A 14-week detailed review culminating in this Evaluation Report.

The 7-day acceptability review was conducted from September 26, 1997, through October 3, 1997. At the conclusion of this review, the SRD was determined to be acceptable for detailed review. The detailed review was conducted from October 3, 1997, through January 12, 1998.

This review was performed by a 22-member review team who evaluated the information and commitments provided in the SRD. The team used the approval criteria in DOE/RL-96-0003 and the review guidance in RL/REG-97-08, formulated RU review questions for BNFL during the review, and made conclusions regarding the extent to which the SRD satisfied the approval criteria in DOE/RL-96-0003.

The review team concluded that the SRD, supplemented by BNFL's responses to the RU review questions, and subject to the conditions presented below, satisfied the evaluation criteria in DOE/RL-96-0003. The review team recommends that the RO approve the SRD subject to the conditions listed below.

Conditions Requiring Resolution As Part A Requirements (Prior to Commencement of Preliminary Design)

Inclusion of Requirements of All Applicable Laws and Regulations, Section 3.1

Compliance With All Other Applicable Regulations, Section 3.1.3

The SRD must be modified to clarify its usage of the term "tailored approach," particularly with respect to 10 CFR 830, Sections 830.1 through 830.7

Conformance to Top-Level Standards and Principles, Section 3.2

Following the submittal and review of the SA Package and during the Regulatory Unit's Review of the BNFL Initial Safety Analysis Report (ISAR), the RU questioned the Contractor's safety approach in several areas; two of which were design classification and subordinate standards. As described in BNFL letter W338-98-0004 dated February 19, 1998, BNFL committed to changes that require significant revision to the SRD. The first change centered on the design classification approach used by BNFL. The second change centered on subordinate standards, as described in BNFL letter 5193-98-0023 dated January 26, 1998. The majority of the following conditions for approval are required as a result of those changes.

Defense in Depth, Section 3.2.3.1.1

BNFL must modify the SRD so that SC 4.3-1 and SC 7.0-2 adequately incorporate Top-Level Principle 4.1.1.5, "Automatic Systems," and Top-Level Principle 4.1.1.3, "Control," respectively. These safety criteria must be modified to include all equipment important to safety instead of Design Class I and II, respectively. Additionally, BNFL must modify the SRD to include subordinate standards for all the safety criteria associated with defense in depth with the exception of SC 4.3-1. BNFL cited adequate subordinate standards in BNFL letter W338-98-0004 dated February 19, 1998 and BNFL letter 5193-98-0023 dated January 26, 1998.

Safety Responsibility, Section 3.2.3.1.2

BNFL must modify the SRD such that safety criteria conform to Top-Level Principle 4.1.2.1, "Safety Responsibility." The proposed safety criteria (SC 7.0-1 and 7.1-3) have not clearly stated that BNFL Inc. has "ultimate responsibility for the safety of the facility." Additionally, BNFL must modify the SRD, as cited in BNFL letter 5193-98-0023 dated January 26, 1998, to include subordinate standards for all the safety criteria associated with the four Top-Level Principles of "Safety Responsibility."

Authorization Basis, Section 3.2.3.1.3

BNFL must modify the SRD, as cited in BNFL letter 5193-98-0023 dated January 26, 1998, to include subordinate standards for all the safety criteria associated with the Top-Level Principle of "Authorization Basis." The authorization basis subordinate standards must reflect the ISMP commitment to clarify the content of the authorization basis and to equate the authorization basis to the licensing basis referenced in the SRD and the ISMP.

Proven Engineering Practices and Margin, Section 3.2.3.2.2

BNFL must modify the SRD to adequately conform to the Top-Level Principles for "Proven Engineering Practices and Margins." Top-Level Principle 4.2.2.2, "Common-Mode/Common-Cause," and Top-Level Principle 4.2.2.3, "Safety System Design and Qualification," do not conform because all aspects of the principles were not addressed. For Top-Level Principle 4.2.2.2, Safety Criteria 4.1-3, 4.1-4 and 4.3-3 only address the effect of natural phenomenon and hazards and not all categories of potential hazards. The reviewers also noted that SC 4.1-3 and SC 4.1-4 establish seismic design criteria for which BNFL has not provided an adequate safety basis (see Section 3.3.1.3). Additionally, these safety criteria only addresses Design Class I and Design Class II SSCs, and not all SSCs "important to safety." With respect to Top-Level Principle 4.2.2.3, Safety Criterion only addresses Design Class I mechanical and electrical equipment instead of <u>all</u> SSCs "important to safety." Also, BNFL must modify the SRD to include adequate subordinate standards for Top-Level Principle 4.2.2.4, "Codes and Standards."

Inherent/Passive Safety Characteristics, Section 3.2.3.2.5

BNFL must modify the SRD to include adequate subordinate standards for Top-Level Principle 4.2.5.1 "Safety Margins Enhancement."

Human Factors, Section 3.2.3.2.6

BNFL must modify the SRD to conform to Top-Level Principle 4.2.6, "Human Factors." Safety Criterion 4.3-4 and Safety Criterion 4.3-6 do not adequately incorporate or conform to this principle because these criteria address only Design Class I and II equipment and not, as a minimum, all equipment "important to safety."

Reliability, Availability, Maintainability, Inspectability (RAMI), Section 3.2.3.2.7

BNFL must modify the SRD to conform to Top-Level Principle 4.2.7.1, "Reliability." The SRD did not provide a safety criterion or subordinate standards for this principle. Additionally, Safety Criterion 4.4-3 must be changed to apply to all SSCs "important to safety."

Pre-Operational Testing, Section 3.2.3.2.8

BNFL must modify the SRD to conform to Top-Level Principle 4.2.8, "Pre-Operational Testing." Of the four principles associated with "Pre-Operational Testing," BNFL does not adequately conform to three. BNFL does not adequately conform to Top-Level Principle 4.2.8.1, "Testing Program," Top-Level Principle 4.2.8.3, "Safety Systems Data," and Top-Level Principle 4.2.8.4, "Design Operating Characteristics," because the proposed safety criteria address only Design Class I and II SSCs, and not all SSCs important to safety. BNFL provided adequate ad hoc subordinate standards in the ISMP for the four principles; however, these standards must be incorporated by reference in the SRD.

Conduct of Operations, Section 3.2.3.3.1

BNFL must modify the SRD to conform to the "Conduct of Operations" Top-Level Principle. BNFL Safety Criteria did not adequately conform to the Top-Level Principle for "Conduct of Operation" for the following reasons. Safety Criterion 7.0-4 does not adequately address or incorporate the "full safety responsibility" aspect of Top-Level Principle 4.3.1.1, "Organizational Structure." Safety Criteria 7.5-2, 7.2-2 and 7.2-4 do not adequately incorporate the "operator experience and qualifications and minimum requirements for the availability of staff or equipment" aspects of Top-Level Principle 4.3.1.4, "Readiness." Safety Criterion 7.1-3 does not adequately address or incorporate the procedure aspect of Top-Level Principle 4.3.1.5, "Internal Surveillance and Audits."

In addition, even though adequate ad hoc subordinate standards are described in the ISMP for the four principles, these standards must be incorporated by reference in the SRD.

Emergency Preparedness, Section 3.2.3.3.3

BNFL provided adequate ad hoc subordinate standards in the ISMP for the three principles of emergency preparedness; however, these standards must be incorporated by reference in the SRD.

Training and Qualification, Section 3.2.3.3.4

BNFL provided adequate ad hoc subordinate standards in the ISMP for the three principles of training and qualification; however, these standards must be incorporated by reference in the SRD.

Operational Testing, Inspection, and Maintenance, Section 3.2.3.3.5

BNFL must modify the SRD to conform Top-Level Principle 4.3.5.1, "Operational, Testing, Inspection and Maintenance." Safety Criteria 7.6-2 through 7.6-4 do not adequately conform because the safety criteria address only Design Class I and II SSCs and not all components "important to safety."

Internal Safety Oversight, Section 3.2.3.4

BNFL must modify the SRD to conform to Top-Level Principle 4.4, "Internal Safety Oversight." The BNFL SRD did not propose a standard or subordinate standard for Top-Level Principle 4.4.3, "Recommendation for Initiation of Construction," BNFL must also modify the SRD to include adequate subordinate standards for Top-Level Principle 4.4.2, "Qualified Personnel."

General Process Safety Overall Principles, Section 3.2.4.1

BNFL must modify the SRD to conform to Top-Level Principle 5.1, “General Process Safety Overall Principles.” BNFL did not adequately incorporate or conform to Top-Level Principle 5.1.1, “Process Safety Management,” because a safety criterion has not been proposed which clearly states that BNFL Inc. has “ultimate responsibility” for facility process safety. Additionally, BNFL must incorporate, by reference, applicable sections of the ISMP into the SRD as subordinate standards for all the safety criteria associated with “General Process Safety Overall Principles.”

Process Safety Management Program, Section 3.2.4.2

BNFL must modify the SRD to conform to Top-Level Principle 5.2, “Process Safety Management Program.” The BNFL SRD does not conform to Top-Level Principle 5.2.6, “Pre-startup Safety Review,” because SC 6.0-5 does not require that the Contractor submit the results of their pre-startup reviews to the Director of the Regulatory Unit for evaluation and in support of authorization decisions and regulatory oversight. Additionally, the BNFL SRD must be modified to include subordinate standards for 9 of the 12 Top-Level Principles of “Process Safety Management Program.” By reference, BNFL must incorporate applicable section of the ISMP in the SRD as subordinate standards.

Issues Requiring Resolution Prior to Construction Authorization

During the evaluation of the SRD, the reviewers identified a number of issues in which BNFL provided insufficient supporting information to reach a safety determination. A detailed description of these issues is found in the Section 3.3, “Assessment of Facility Hazards and Operations Hazards,” or Section3.6, “Safety Adequacy of the SRD.” These are issues that are commonly resolved during preliminary design, but essential to resolve prior to construction, since later resolution could result in adverse project cost and schedule impacts.

Assessment of Facility Hazards and Operations Hazards, Section 3.3

Nitric Acid and Resin Addition, Section 3.3.1.1.4

BNFL must finalize the hazards associated with disposition of the spent resin by incineration in the LAW melters (see Question 128).

Site Description, Section 3.3.1.3

BNFL must provide adequate justification to support their hazards approach for the natural phenomena hazards (NPH) design criteria described in the HAR (see Section 3.6.2.1, “General Design”).

BNFL must provide adequate justification to support the hazards approach used for their seismic design criteria. BNFL did not provide an adequate or sufficiently detailed safety basis to support the selection of a 0.24 vertical acceleration earthquake with a 2000-year return period.

Analysis of Facility Hazards, Section 3.3.2.3

BNFL must provide adequate justification to support their hazards approach for the hydrogen generation and potential explosions of flammable gases in process vessels in the waste receipt process area.

BNFL must provide adequate justification to support their hazards approach for criticality.

Safety Adequacy of SRD, Section 3.6

Adequacy of Process Control Strategies, Section 3.6.1.1

To assure adequate safety, BNFL must provide adequate safeguards (hazards control strategies) for water removal during cesium recovery, accidents involving HVAC filter machine crushing, and breaches of HVAC ductwork.

To assure adequate safety, BNFL must provide adequate safeguards (hazards control strategies) to prevent the accumulations of flammable gases in process vessels (i.e., the feed receipt tank and cesium storage tank).

Adequacy of Facility Hazards Control Strategies, Section 3.6.1.2

To assure adequate safety, BNFL must provide adequate safeguards (hazards control strategies) for “bulk chemical” hazards in the Wet Chemical Storage Building and Glass Formers Storage Building (see response to Question 34).

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Appendixes

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1.0 Introduction

This Evaluation Report assesses the adequacy of the standards set proposed in the BNFL *Safety Requirements Document* (SRD), BNFL-5193-SRD-01, Rev. 0. The SRD is one of six documents comprising the BNFL Standards Approval (SA) Package identified by Table S4-1 of the DOE Contract with BNFL Inc. (DE-AC06-96RL13308 [the Contract]). The SRD was submitted to the U.S. Department of Energy, Richland Operations Office (RL) Director of the Office of Radiological, Nuclear, and Process Safety Regulation of the Tank Waste Remediation System (TWRS) Privatization Contractors [Regulatory Official (RO)], on September 26, 1997.

The purpose of the SA regulatory action, in part, is to approve the Contractor-recommended set of radiological, nuclear, and process safety standards and requirements that are documented in the SRD.

- The SA regulatory action is being conducted in accordance with *DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors*, DOE/RL-96-0003. DOE/RL-96-0003 provides the process to be followed during the SA regulatory action and the criteria to be met by the BNFL Safety Requirements Document (SRD).

This Evaluation Report provides recommendations regarding approval of the SRD. The review of the SRD was planned and executed in accordance with the *BNFL Inc. Standards Approval Review Planning Handbook*. The technical basis for the RU's review is contained in *Guidance for the Review of TWRS Privatization Contractor Safety Requirements Document Plan Submittal Package*, RL/REG-97-08. RL/REG-97-08 also was made available to BNFL for information purposes.

The completeness and adequacy of the BNFL SA Package for technical review was determined by an Acceptability Review. The Acceptability Review was based on the SA submittal requirements listed in DOE/RL-96-0003, relative to the SRD. Upon completion of the Acceptability Review, a Detailed Review was performed following the SA approval criteria outlined in RL/REG-97-08, in accordance with those criteria listed in DOE/RL-96-0003.

1.1 Overview of the BNFL Proposed Facility

The proposed BNFL TWRS-Privatization (TWRS-P) facility will be designed to immobilize waste from the Hanford Site underground waste storage tanks into a glass product that is encased in stainless steel canisters for long-term storage. Two options have been proposed for the BNFL TWRS-P facility. They are referred to as the low-activity waste (LAW)-only option and the high-level waste (HLW)/LAW option. Both options are designed to process the three different LAW waste feeds (liquids with low solids content) designated as Envelopes A, B, and C in the Contract. The HLW/LAW option is designed to process the HLW feed (a solids-bearing liquid slurry) designated as Envelope D in the Contract.

The planned BNFL TWRS-P complex consists of a radioactive waste treatment building and several supporting structures (an immobilized waste container shipping building, a melter assembly building, an empty container storage building, a wet chemical storage building, a glass formers storage building, a service building, and an administration building). The waste pretreatment and vitrification processes are housed in remotely-operated hot cells within the radioactive waste treatment building. The major processing steps inside the hot cells include the following:

- Feed receipt
- Feed evaporation
- Solids removal by ultrafiltration
- Cesium and technetium removal by ion exchange
- Cesium recovery as a solid (LAW-only option)
- Melter feed preparation
- LAW vitrification
- HLW vitrification (HLW/LAW option)
- Vitrification offgas treatment.

The U.S. Department of Energy (DOE) will provide waste feed for the plant to an existing double-shell tank (241-AP-106). From there it will be transferred, in batches, through an underground pipe to feed receipt tanks in the radioactive waste treatment building.

LAW is processed by ultrafiltration and feed evaporation steps to separate the waste into concentrated solids and liquid fractions and to adjust the liquid stream sodium concentration. The liquid stream is then passed through ion exchange columns to remove cesium and technetium before it is concentrated and blended with glass-forming additives in the LAW melter feed preparation tank. From this vessel, the mixture is sent to the LAW melter for vitrification. Molten glass is poured from the melter into stainless steel storage canisters. After waste vitrification, the waste canisters are sealed, decontaminated, and transferred to an interim storage facility.

For HLW, the separation of solids and radionuclides is unnecessary because these components will be incorporated and immobilized in the HLW product. The HLW will be mixed with glass-forming additives in the HLW melter feed preparation tank and then vitrified in an HLW melter. The vitrified HLW will be removed from the melter in a manner similar to the LAW.

2.0 Review Process

Guidance for performing the RU staff review of the SRD is contained in RL/REG-97-08. Review of the SRD is included in the review process for the SA Package, as described in the DOE/RL-96-0003. The reviewers also considered other information drawn from their individual experience and expertise in formulating their conclusions.

2.1 SRD Review Approach

The reviewers systematically evaluated the SRD using the criteria established in DOE/RL-96-0003. The SRD review process consisted of the following steps:

- Receipt of Contractor SA Package

- Acceptability Review of SA Package (a 7-day review to determine whether the submittal was acceptable for detailed review)

- Detailed Review of SA Package, including transmittal of RU requests for information (a 14-week review culminating in this Evaluation Report), including transmittal of RU requests for information

- Receipt and disposition of Contractor responses to RU information requests

- Contractor-hosted meeting with the RU

- Preparation of draft SRD and Integrated Safety Management Plan (ISMP) Evaluation Reports

- Public and Contractor comment on the draft Evaluation Reports

- Finalization and issuance of the final Evaluation Reports

This Evaluation Report documents the results of the first six steps listed above. The acceptability Review was based on the SA submittal requirements relative to the SRD, as stated below:

> "The Standards Approval submittal package shall consist of the following documentation:
>
> 1) The Contractor's recommended set of radiological, nuclear, and process safety standards for design, construction, operation, deactivation, and regulatory submittals in the form of a SRD;
>
> 2) The Contractor's certification that the set of radiological, nuclear, and process safety standards in the SRD will, when implemented, provide adequate safety, comply with all applicable laws and regulations, and conform to the DOE-stipulated top-level safety standards and principles;
>
> 3) The hazards assessment used to facilitate the selection of the standards;
>
> 4) The hazards control strategy implemented in the design and proposed operations;
>
> 5) Description of the process and facility design and its proposed operation;
>
> 6) The Contractor's treatment of the top-level radiological, nuclear, and process safety standards and principles;
>
> 7) The rationale for the selection of the standards and the adequacy of the set;
>
> 8) The standards identification process used and the credentials of the participants;
>
> 9) The standards confirmation process used and the credentials of the participants;
>
> 10) The Contractor's approval process used for the set of standards and the basis for the approval."
>
> "The approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the Director of the Regulatory Unit that:

1) The set documented in the SRD includes all requirements of applicable laws and regulations;

2) The set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in the DOE-provided document titled *Top-level Radiological, Nuclear, and Process Standards and Principles for TWRS Privatization Contractors,* DOE/RL-96-0006, Revision 0;

3) The hazards associated with the proposed facility and its operation are appropriately assessed;

4) The set documented in the SRD was generated through the appropriate implementation of the standards process stipulated by DOE in the document titled *Process for Establishing a Set of Radiological, Nuclear, and Process Safety Standards and Requirements for TWRS Privatization,* DOE/RL-96-0004, Revision 0;

5) Appropriate expertise was employed in the standards selection and confirmation processes; and

6) The set documented in the SRD will provide adequate safety if properly implemented."

The findings of the Detailed Review are contained in this SRD Evaluation Report and have been sequentially organized in this report to be compatible with the Approval Criteria noted above. After completion of public and Contractor comment periods, this report will be provided to the RO, who will make the final determination regarding approval and subsequent issuance of the SRD.

2.2 Chronology

Preparation for the review was initiated before receipt of the BNFL Inc. SA Package. The RU review team received formal training on the guidance material and other related documents. The major review milestones are shown in Table 2.2-1.

2.3 Team Composition and Expertise

The names, levels of education, and expertise of the SA Package review team are provided in Table 2.3-1. The BNFL SA Package review team leader was Mr. Robert C. Barr. Mr. Clark L. Vanderniet and later Mr. Albert R. Hawkins were the assistant team leaders.

Table 2.2-1. BNFL SA Package Review Chronology.

Milestone	**Date(s) 1997**
Receipt of SA Package from BNFL	September 26
Acceptance of SA Package by DOE	October 3
RU review team requests for additional information (Questions)	October 17, 24, 31
BNFL responses	November 11
Disposition of BNFL responses by RU review team sent to BNFL	November 26
BNFL follow-up responses to review team disposition	December 8
Significant meetings/events: • RU review team orientation • BNFL public presentation of SA Package submittal • BNFL SA Package presentation to RU review team • Submission of NRC questions to BNFL	 September 22 September 25 September 26 December 8

Table 2.3-1. Review Team Membership Education and Expertise. (3 sheets)

Review team member	**Education/expertise**
Robert Barr	B.S. Organic and Inorganic Chemistry. Senior Reactor Operator Certified, Nuclear Engineering Officer (USN); Certified NRC Senior Resident Inspector for Pressurized and Boiling Water Reactors. More than 25 years of nuclear experience.
Clark Vanderniet	B.I.S., M. Ed., Senior Reactor Operator Certified; Certified NRC Senior Resident Inspector for Pressurized and Boiling Water Reactors; Certified DOE Nuclear Safety Assessor. More than 25 years of nuclear experience.
Rey Bocanegra	B.A. Chemistry, M.S. Nuclear Engineering, M.S. Health Physics. Part I HP Certification; Certified DOE Facility Representative; NQA-1 Lead Nuclear Auditor; DOE Certified Accident Investigator. More than 12 years of radiation protection expertise.
Jay Boudreau	B.S./M.S./Ph.D. in Engineering. Member, National Research Council; senior policy support to U.S. Government. More than 20 years experience in safety analysis, including hazards analysis, probabilistic risk analysis, and systems analysis.
Frank Chen, P.E.	B.S./M.S./Ph.D. in Nuclear Engineering. Senior Reactor Operator. 17 years experience in nuclear industry; expertise in nuclear safety, design, operations, analysis, radiation shielding, dose calculation, thermal hydraulics, safety education, emergency preparedness, hazard evaluation.

Table 2.3-1. Review Team Membership Education and Expertise. (3 sheets)

Review team member	Education/expertise
Thomas Colandrea, P.E.	B.S. Metallurgical Engineering, M.S. Engineering Science and Metallurgy, MBA; P.E. (California). ASQC Certified Quality Engineer, Reliability Engineer, and Quality Auditor; ISO 9000 Certified Lead Auditor; ASQC Fellow. 35 years experience in Nuclear QA and metallurgical engineering.
James Cunnane	Ph.D. Nuclear & Radiochemistry. 22 years of nuclear facility experience. Expertise in radiochemistry, vitrification of radioactive waste, safety analysis including consequence analysis, and TWRS vitrification.
Michael Elliott	B.S./M.S. Chemical Engineering. 11 years experience in environmental process development including ceramic melters, radioactive glass fabrication and leaching, and development of waste glasses and vitrification systems.
Pranab Guha	M.S. Electrical Engineering; P.E. (Pennsylvania). Expert in electrical and control systems design, failure mode and effects analysis of electrical and electromechanical systems for safety and reliability.
Roy Hardwick	B.S./Ph.D. Chemical Engineering. Two chemical process patents. 30 years experience in chemical process system safety analysis and documentation, development and scale-up, chemical plant design, process operations and control.
Donald G. Harlow	B.S. Chemical Engineering. Special skills in process engineering and process control. Expertise in Hanford Site nuclear chemical and mixed-waste processing operations including TWRS, B Plant, PUREX, Plutonium Finishing Plant.
Mary Haughey	B.A. Engineering, B.S. Mechanical Engineering and Material Science. Experience in mechanical equipment design for commercial reactors; NRC technical reviewer for equipment qualification; Supervisory engineer for reactor restart; NRC licensing Project Manager.
Al Hawkins	B.S. Chemical Engineering, MBA. More than 25 yr experience in operations, oversight, safety and quality assurance. Former Manager of Compliance Assurance and Director of Environment, Safety, Health and Quality Assurance.
John Hockert	B.S. Physics, M.A/Ph.D. Nuclear Physics. NQA-1 Certified Auditor. More than 7 years with NRC Office of Nuclear Material Safety and Safeguards; managed Pantex Plant Hazards Assessment; extensive experience in regulatory oversight, safety analyses, and compliance plan development.
Thomas Hull	B.S. Chemical Engineering, M.S. Management. Navy Certified Nuclear Plant Chief Engineer. Expertise in team management, conduct of operations, and TWRS privatization development.
Neal Hunemuller	B.S. Nuclear Engineering. Certified NRC Operator Licensing Examiner; Licensed NRC Senior Operator. More than 15 years experience in commercial nuclear power and in the NRC.

Table 2.3-1. Review Team Membership Education and Expertise. (3 sheets)

Review team member	Education/expertise
Dennis Kubicki	B.S. Fire Protection, M.S. Safety. Certified fire fighter. Previous fire safety experience with Maryland State Fire Marshall's Office, General Services Administration, NASA, NRC, DOE; expertise in fire protection.
C.K. Liu	Ph.D. Nuclear Radiochemistry. NQA-1 Lead Nuclear Auditor. 15 years experience as manager of a radiochemistry laboratory for the EPA; expertise in the areas of chemical process safety, nuclear process chemistry, and health physics.
Jeff Martin	B.S./M.S./Ph.D. Nuclear Engineering. More than 20 years experience in reactor and nuclear facility safety, regulation, and analysis including advanced fast reactors, new production reactor, and Russian nuclear material storage.
Matthew Moeller	B.A. Mathematics, M.S. Environmental Health; HP Society Fellowship; 1992 Health Physicist of the Year for the Health Physics Society (Columbia Chapter). 17 years experience supporting DOE & NRC. Expertise in radiation protection regulation, enforcement, consequence assessment.
Joseph Perez	B.S./M.S. Chemical Engineering. More than 15 years experience in vitrification process development and design including full-scale equipment design, flowsheet studies, feed stream simulation, test design, and equipment maintenance and operation.
Subir Sen	B.S./M.S./Ph.D. Structural Engineering; Registered P.E.; Participant in NRC's Severe Accident Phenomena Study and member of the National Code Committee developing design codes for nuclear facilities. 22 years experience in the design, safety analysis, and risk evaluation of nuclear power plants and other nuclear facilities.
Brian Vonderfecht	B.S./Ph.D. Nuclear Physics. Proficient in accident modeling and safety document preparation. 12 years experience in developing fault-tree and event-tree failure modes for complex plant systems and in analyzing plant failure events.

3.0 Findings

The following sections sequentially address the contractual approval criteria cited in DOE/RL-96-0003.

3.1 Inclusion of Requirements of All Applicable Laws and Regulations

The main focus of this part of the review was to determine if the SRD included all requirements of applicable laws and regulations. The submittal requirements and approval requirements for the inclusion of applicable laws and regulations are listed in DOE/RL-96-0003. Guidance for this part of the review centered on verifying that the set of radiological, nuclear, and process safety (RNPS) standards, when implemented, will comply with all applicable laws and regulations.

3.1.1 Compliance with 10 CFR 835

Requirements

DOE/RL-96-0003 requires, in part, that the Contractor certify that the set of RNPS standards in the SRD will, when implemented, comply with all applicable laws and regulations. DOE/RL-96-0004, specifically includes the DOE nuclear safety regulation 10 CFR 835, "Occupational Radiation Protection," as an applicable law and regulation. Pursuant to DOE/RL-96-0003 and in order to approve the Contractor's recommended set of RNPS standards and requirements, the RO must make a final determination that the set documented in the SRD includes all requirements of applicable laws and regulations.

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to 10 CFR 835. The information provided by BNFL was assessed to ensure that: (1) the SRD contained all requirements of 10 CFR 835; and (2) other standards in the recommended set did not conflict with the requirements of 10 CFR 835.

This evaluation was conducted through a review of the material presented in the SRD and the resolution of questions developed during the review.

Evaluation

BNFL SRD, Vol. I, Section 3.3.1, "Sources of Standards of Safety Criteria," indicates the inclusion of 10 CFR 835 requirements in the SRD Safety Criteria standards. To assess the adequacy of compliance with 10 CFR 835, the reviewers performed a comprehensive examination of the set of RNPS standards documented in the BNFL SRD, Vol. II, against the requirements specified in 10 CFR 835. The BNFL SRD, Vol. I, Attachment E, "Compliance with Applicable Laws and Contract Requirements," was used to assist in the review. As a result of this review and a subsequent concern (Question 1), the reviewers identified discrepancies related to the standards set missing or not adequately addressing numerous 10 CFR 835 requirements; changing the scope or intent of numerous requirements; contradicting several requirements (thereby ensuring noncompliance); and changing key words or phrases that could change the intent of several requirements.

BNFL responded to Question 1 by addressing and resolving the issue of whether compliance with 10 CFR 835 is required by the selected set of standards. A commitment of compliance with 10 CFR 835 appears in the set of selected standards, with the addition of a new Safety Criterion 1.0-10. This criterion states that "In addition to the Safety Criteria contained herein, compliance with all requirements of 10 CFR 830.120 and 10 CFR 835 shall be achieved absent the granting of an exemption request to any specific requirement therein." However, a supplemental question was asked under Question 1 to determine the location of explicit nuclear safety requirements of 10 CFR 835 in the BNFL SRD. BNFL responded with a revision to Chapter 5.0 of the SRD. Safety criteria potentially contradictory to 10 CFR 835 appear to have been removed; Safety Criterion 5.0-1 was added to state that the Radiation Protection Program (RPP) shall be developed and submitted compliant with 10 CFR 835 and that the content of the RPP shall address all items in 10 CFR 835. The reviewers consider the term "items" to mean "explicit nuclear safety requirements" in this context. The reviewers did not consider the BNFL submittal to be in conformance with this contract requirement until the revisions were incorporated into the SRD. The revisions ensure a commitment to full compliance with 10 CFR 835.

Conclusions

The SRD provides a recommended set of radiological, nuclear, and process safety standards containing all requirements of 10 CFR 835. The standards set recommended by BNFL provides adequate conformance to DOE/RL-96-0004, specifically, in that the SRD contains the nuclear safety requirements of 10 CFR 835.

3.1.2 Compliance with 10 CFR 830.120

Requirements

DOE/RL-96-0003 requires that the BNFL SRD include standards for nuclear safety management features required by DOE regulations, particularly 10 CFR 830, "Nuclear Safety Management." Pursuant to DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the set documented in the SRD includes all requirements of applicable laws and regulations (including 10 CFR 830.120, "Quality Assurance Requirements").

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to 10 CFR 830.120. The information provided by BNFL was assessed to ensure that: (1) BNFL's set of RNPS standards and requirements includes 10 CFR 830.120 requirements; and (2) the BNFL SRD includes provisions to ensure compliance with 10 CFR 830.120.

This evaluation was conducted through review of the material presented in the BNFL SRD and the resolution of questions developed during the review process.

Evaluation

BNFL SRD, Vol. I, Attachment D, "SRD Development Basis Documents," states that 10 CFR 830.120 is a statutory requirement. The BNFL SRD, Vol. I, Attachment E, "Compliance with Applicable Laws and Contract Requirements," describes where the requirements from selected laws and regulations are incorporated into the SRD. This attachment provides a tabular summary identifying the SRD section number and title for each applicable requirement of 10 CFR 830.120. Most of the entries in this table reference the BNFL SRD, Vol. II, Section 7.3, "Quality Assurance Program," in which all of the safety criteria comprising the quality assurance (QA) elements contained in 10 CFR 830.120 are discussed.

To assess the adequacy of compliance with 10 CFR 830.120, the reviewers performed a comprehensive examination of the set of RNPS standards documented in the BNFL SRD, Vol. II, against the requirements specified in 10 CFR 830.120. The SRD, Volume I, was used to assist in the review. The reviewers found that most of the requirements specified in 10 CFR 830.120 were appropriately contained in the documented set of standards. However, in two instances, a 10 CFR 830.120 requirement was either not included or not adequately addressed in the set (Question 155). BNFL responded to this issue by restating its commitment to fully comply with 10 CFR 830.120 and indicating that a Safety Criterion (1.0-10) would be added to Vol. II of the BNFL SRD.

Conclusions

BNFL establish safety criteria that provide a commitment to full compliance with 10 CFR 830.120.

3.1.3 Compliance With All Other Applicable Regulations

Requirements

In accordance with the Contract provisions, TWRS privatization is required to meet the provisions of applicable laws and regulations. This review for adherence to applicable laws and regulations focused on the previously noted 10 CFR 835 and 10 CFR 830.120, which are the major regulations issued by DOE in response to the Price-Anderson Amendments Act of 1988. However, the reviewers also considered how the Contractor met the provisions of 10 CFR 820, “Procedural Rules for DOE Nuclear Activities,” and applicable parts of 10 CFR 830, "Nuclear Safety Management.”

Review Methodology

The reviewers considered the standards identification process as it relates to compliance with 10 CFR 820 and 830. In particular, the reviewers evaluated whether appropriate aspects of the law were identified and committed to in the SRD.

10 CFR 820 defines the procedures to be followed by DOE and its contractors, subcontractors, and suppliers with respect to reporting, enforcement, civil penalties, compliance orders, interpretations, exemptions, and criminal penalties. It does not impose substantive policy requirements. The procedural requirements of 10 CFR 820 are invoked in specific circumstances; for example, the identification of a potential noncompliance with a substantive nuclear safety rule and subsequent activities with respect to investigation by DOE.

10 CFR 830 contains general requirements to be applied to nuclear safety management activities. 10 CFR 830.1, “Scope,” 10 CFR 830.2, “Exclusions,” and 10 CFR 830, “Definitions,” define the scope, exclusions, and the definitions for the nuclear safety management rules. 10 CFR 830.4, “General Rule,” defines general responsibilities with respect to implementation of the substantive rules. 10 CFR 830.6, “Records,” requires the Contractor to maintain complete and accurate records to substantiate compliance with the nuclear safety management rules. 10 CFR 830.7, “Graded Approach,” defines responsibilities with respect to applying the graded approach to substantive rules.

The reviewers evaluated whether these general requirements are incorporated into the discussion of implementation of the specific substantive rules. However, for some sections (i.e., 10 CFR 830.2, 10 CFR 830.3, and 10 CFR 830.4), the reviewers did not expect a separate implementation discussion. In such cases, unless the Contractor intends to deviate from the requirement and requests an exemption, the reviewers assumed that the Contractor intends to comply with the requirement as written.

Evaluation

BNFL did not include a specific commitment to 10 CFR 820 in the SRD. However, unlike 10 CFR 830 and 835, 10 CFR 820 contains procedural rules, not substantive rules. The DOE does not require or expect the Contractor to provide an implementation plan for 10 CFR 820. In fact, the majority of the provisions in 10 CFR 820 define the actions and procedures to be followed by the DOE in certain defined circumstances. Should circumstances occur at the TWRS-P facility which would require the Contractor to follow the procedures defined in 10 CFR 820, such as an enforcement action or the need for an exemption to the nuclear safety rules, the Contractor would be expected to do so at that time.

During the review process, the reviewers noted that the term "tailored approach" appears to be used interchangeably with the term "graded approach" throughout the SRD (and the *Integrated Safety Management Plan* [ISMP], BNFL-5193-ISP-01). In particular, tailored approach was used in place of graded approach in Safety Criteria 7.2-1, 7.5-1, and 7.6-1, which address commitments to draft rules. Graded approach is defined in 10 CFR 830.3 of the rules. However, "tailored approach" is not defined in the rules and has been used within the DOE to define a different process.

When a graded approach is applied, the Contractor adjusts the rigor of the application of a requirement as appropriate to the application, but continues to meet the requirement. For example, if a requirement states that all valves in a certain system shall be performance tested, but does not specify the frequency of the test, the Contractor may apply a graded approach by using a higher testing frequency on valves with more safety significance. In some parts of DOE the term tailoring is used differently. To illustrate using the same example, if a standard states that all valves in a certain system shall be tested and the Contractor determines that only selected valves with higher safety significance will be tested, that is tailoring. An exemption is required if a Contractor uses the tailoring process, as described, with respect to 10 CFR 830.3 Rules relating to the graded approach. For the TWRS-P Contracts, however, the terms "graded approach" and "tailored approach" are essentially the same; both mean that actions are proportional to the relative hazard under consideration. There may be instances where tailoring may require exemptions to existing Rules.

<u>Conclusions</u>

The reviewers concluded that with respect to 10 CFR 820, the Contractor's commitment in the ISMP to provide training and procedures on 10 CFR 820 is adequate. With respect to 10 CFR 830, Sections 830.1 through 830.7, the reviewers concluded that the Contractor should clarify its usage of the term "tailored approach."

3.2 Conformance to Top-Level Standards and Principles

DOE/RL-96-0003 requires the Contractor to conform to the top-level safety standards and principles of DOE/RL-96-0006. First, the Contractor must address these top-level standards and principles in their standards and requirements and , second, the Contractor shall incorporate the top-level radiological, nuclear, and process standards and principles into the recommended standards and requirements. Furthermore, DOE/RL-96-0005 requires that the Contractor identify a set of subordinate standards and requirements that, when properly implemented provide adequate safety, comply with legal requirements and conform to the top-level standards and principles. The following sections describe the reviewers' evaluation of the Contractor's conformance to these standards and principles.

3.2.1 Radiological and Nuclear Safety Standards

Requirements

DOE/RL-96-0003 requires that the SA Package, including the Contractor's recommended set of radiological, nuclear, and process safety standards for design, construction, operation, deactivation, and regulatory submittals, be in the form of an SRD. The Contractor shall certify that the standards set, when implemented, will provide adequate safety, comply with all applicable laws and regulations, and conform to the DOE-stipulated top-level standards and principles contained in DOE/RL-96-0006. DOE/RL-96-0003 also states that the SRD shall consist of the Contractor's treatment of the top-level radiological, nuclear, and process safety standards and principles. The top-level radiological, nuclear, and process safety standards for an individual are those listed in DOE/RL-96-0006, Table 1 for workers, co-located workers, and the public, for normal operation and credible accident conditions. Pursuant to the DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the documented standards set conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006 complies with the law and will provide adequate safety if properly implemented.

The Contractor's SRD is required to conform to three types of top-level radiation dose standards, as specified by the DOE in DOE/RL-96-0006, Table 1. The three types are defined as follows:

- Radiation Dose Standard Applicable to Workers and Co-located Workers: This radiation dose standard (in units of rem/year or rem/event) addresses external and internal whole body, partial body, and organ exposures.

- ALARA Design Limit: This as low as reasonably achievable (ALARA) Design Limit (in units of rem/year or rem/event) is applicable to workers and co-located workers. This type of standard is consistent with ALARA design objectives used to evaluate engineering features under normal operations, as presented in 10 CFR 835. The design objective establishes an exposure level value, in units of mrem per hour, to control the potential exposure of a radiological worker. In general terms the facility shall be designed to maintain exposures to radiological workers at 20 percent of the applicable standards and as far below this average as reasonably achievable. For anticipated events, the design standard is not a dose limit but rather the specification of a process with the objective of optimizing the selection of safeguards during the design phase. The ALARA design standard specifies the event consequence (as a radiation exposure value) above which the documented ALARA design engineering program must be applied to evaluate potential safeguards affecting the event sequence. From a design perspective, this value represents a threshold level for the consequence of an accident, above which an ALARA evaluation would be performed to determine whether a potential engineering feature would be optimal, given economic and societal considerations. If a potential engineering feature were determined to be cost-effective and feasible, it would be incorporated into the facility design.

- Radiation Dose Standard Applicable to the Public : This radiation dose standard is a total (internal and external) effective dose equivalent or effective dose equivalent to the thyroid, (in units of rem/year or rem/event), from a specific pathway or source.

DOE/RL-96-0006, Table 1, specifies four event probability ranges addressing normal operation and credible accident conditions. The associated event ranges are normal events, anticipated events, unlikely events, and extremely unlikely events. Normal events are typical of normal facility operations and are expected to occur regularly in the course of facility operations; the associated probability of occurrence during the lifetime of the facility is one per year. A general guideline for this event probability is that normal modes of operating the facility systems should provide adequate protection of health and safety.

Anticipated events are characterized as minor incidents and upsets of moderate frequency that may occur once or more during the lifetime of the facility; the associated probability range is 1×10^{-2} to less than one per year. A general guideline for this event probability range is that the facility should be capable of returning to operation without extensive corrective action or repair.

Unlikely events are characterized as more severe incidents that are not expected, but may occur during the lifetime of the facility; the associated probability range is 1×10^{-4}/yr to 1×10^{-2}/yr. A general guideline for this event probability range is that the facility should be capable of returning to operation following potentially extensive corrective action or repair, as necessary.

Extremely unlikely events are characterized as events that are not expected to occur during the lifetime of the facility but are postulated because their consequences would include the potential for the release of significant amounts of radioactive material; the associated probability range is 1×10^{-6}/yr to 1×10^{-4}/yr. A general guideline for this event probability range is that facility damage may preclude a return to operation. (For example, the probability of occurrence of 1×10^{-2}/yr is equivalent to a probability of one occurrence in 100 years; 1×10^{-4}/yr to one in 10,000 years; and 1×10^{-6}/yr to one in 1,000,000 years.)

DOE/RL-96-0006, Table 1, requires a contractor to derive standards for both the worker and the co-located worker at the accident probability ranges of unlikely events and extremely unlikely events. A footnote to the four entries in the "To be derived" column of Table 1 states that specific limits are to be derived and proposed by the Contractor, and that examples of such derived limits and implementation approaches are described in *Methods for the Assessment of Worker Safety Under Radiological Accident Conditions at Department of Energy Nuclear Facilities*, EH-12-94-01, June 1994. The footnote also states that the specific limits will be finalized as part of the standards identification and approval activities to be performed early in Part A of the program.

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006. The information provided by BNFL was assessed to ensure that: (1) BNFL adequately addressed and conformed to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, Table 1; (2) BNFL's recommended set of individual standards, when implemented, will provide for adequate safety of applicable activities during design, construction, operation, and deactivation; and (3) BNFL provided adequate justification of the appropriateness of the set of individual standards based on considerations of the work activities, associated hazards, and selection of hazard control strategies.

The individual radiological and nuclear standards are presented in DOE/RL-96-0006, Table 1. They include the human dose standards with which all facility activities of the contractor involving radiological and nuclear hazards must comply, and ALARA design standards that ensure the identification and incorporation of cost-effective and feasible safeguards to prevent and mitigate radiological exposures. These standards are consistent with radiological exposure limits embodied by DOE and NRC regulations and with the perspectives of the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP).

BNFL was required to provide a regulatory deliverable, *Radiation Exposure Standard for Workers Under Accident Conditions* (BNFL RESW), that addresses and incorporates the top-level standards and principles of DOE/RL-96-0006, Table 1.

The deliverable is presented in *Radiological and Nuclear Exposure Standards for Facility and Co-located Workers*, BNFL-5193-RES-01. The Evaluation Report for the RESW is included as Appendix B to this Evaluation Report. Revisions to the deliverable document were provided on December 8 and 17, 1997, as part of the review question and resolution process. Table A of the BNFL submittal corresponds to DOE/RL-96-0006, Table 1. This evaluation was conducted through a review of the material presented in the BNFL RESW, the SRD, and the resolution of questions developed in the review process.

A review of the BNFL RESW was performed in conformance to the methodology for review of the BNFL SA Package submittal contained in RL/REG-97-08. The review was performed using guidance provided in *Guidance for Review of TWRS Privatization Contractor Radiation Exposure Standards for Workers*, RL/REG-97-09. Other documents referred to during this review included the following:

- 10 CFR 20, “Standards for Protection Against Radiation,” Final Rule, as amended
- 10 CFR 60.136, “Preclosure Controlled Area,” Draft Rule
- 10 CFR 70, “Domestic Licensing of Special Nuclear Material,” Final Rule, as amended
- 10 CFR 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste,” Final Rule, as amended
- 10 CFR 100, “Reactor Site Criteria,” Final Rule, as amended
- 10 CFR 834, “Radiation Protection of the Public and the Environment,” Draft Rule
- 10 CFR 835, “Occupational Radiation Protection,” Final Rule
- DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, 1994

- EH-12-94-01, *Method for the Assessment of Worker Safety under Radiological Accident Conditions at Department of Energy Nuclear Facilities*, Vol. 1, “Main Report,” and Vol. 2, “Appendixes,” 1994

- SEN-35-91, *Nuclear Safety Policy*, Secretary of Energy Notice, 1991

- ICRP Publication 55, *Optimization and Decision-Making in Radiological Protection*, September 1988

- NBS Handbook 69, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for Occupational Exposure*, 1963

- Westinghouse, *GOCO Radiological Engineering Guide*, November 1996

- Letter from Walter B. Scott, DOE-RL to Contractors, “Clarification of Hanford Site Boundaries for Current and Future Use in Safety Analysis,” 1995; Letter from Elizabeth D. Sellers, DOE-RL to Fluor Daniel Hanford, Inc., “Risk Evaluation Guidelines (REGs) to Ensure Inherently Safe Designs,” 1997.

Evaluation

As documented in this BNFL SRD Evaluation Report, all standards and subordinate (implementing) standards proposed in the RESW by BNFL for the public conform to the applicable top-level standards, comply with all applicable laws and regulations, and provide an adequate level of safety. During review of the BNFL RESW, questions from the Regulatory Unit and responses from BNFL regarding the BNFL RESW, Table A, were frequently exchanged. Significant questions pertaining to other standards proposed in the BNFL RESW were Questions 158, 159, and 160.

Question 158 identified issues on conformance of the BNFL proposed standards addressing the DOE-specified top-level standards for the ALARA Design Limit for workers and co-located workers at the normal event probability. In each case, the top-level standard is listed in DOE/RL-96-0006, Table 1, as ≤ 1.0 rem/year ALARA design limit. Tailored ALARA Design Limit standards for the normal event probability range are proposed in the BNFL SRD, Table A. This table lists the ≤ 1.0 rem/yr design objective per 10 CFR 835.1002(b), with a footnote stating that:

> “In addition to meeting the listed design objective of 10 CFR 835.1002(b), the inhalation of radioactive material by workers and co-located workers under normal conditions is kept ALARA through the control of airborne radioactivity as described in 10 CFR 835.1002(c).”

The proposed standards are equivalent to the applicable top-level ALARA design limit standards, provide an adequate level of safety, and ensure that cost-effective safeguards affecting normal events are evaluated (and incorporated as appropriate) in accordance with the ALARA design objectives of 10 CFR 835. The proposed standard addresses the control of both external and internal (from inhalation) radiation exposures.

One aspect of Question 159 identified issues on conformance of the BNFL proposed standards addressing the DOE-specified top-level standards for the ALARA design limit for workers and co-located workers at the anticipated event probability range. In each case, the top-level standard is listed in DOE/RL-96-0006, Table 1, as ≤ 1.0 rem/event ALARA Design Limit. The BNFL SRD, Table A, redefines the normal and anticipated event probability ranges; minor incidents and upsets having an associated frequency of greater than 1×10^{-1}/yr were included in the normal events range. The BNFL SRD, Table A, proposes tailored ALARA Design Limit standards for the redefined anticipated event probability range (1×10^{-2}/yr to 1×10^{-1}/yr). Table A lists the 1.0 rem/event Design Action Threshold with a footnote stating that:

> "When a calculated accident exposure exceeds this threshold, then appropriate actions are taken. These include carrying out a less bounding (i.e., more realistic) evaluation to show that the accident consequences will be below the threshold or evaluating additional safeguards for cost-effectiveness and/or feasibility. This threshold is not a limit; it does not require the implementation of additional preventive or mitigative features if they are not both cost-effective and feasible."

The proposed standards are equivalent to the applicable top-level standards, provide an adequate level of safety, and ensure that cost-effective safeguards affecting anticipated events are evaluated (and incorporated as appropriate) whenever the final calculated event consequence to a worker or co-located worker is 1 rem or more. A second aspect of Question 159 identified issues on conformance of the BNFL proposed standards addressing the "To be derived" entries (see DOE/RL-96-0006, Table 1) for workers and co-located workers at the unlikely and extremely unlikely events probability range. While not explicitly required by the "To be derived" entries listed in Table 1, the RU review team evaluated the proposed standards to determine whether cost-effective and feasible safeguards would be evaluated by the Contractor for accidents under these event ranges to ensure adequate safety.

BNFL has provided additional justification ensuring that its proposed standards, as listed, meet this objective. Table A proposes a ≤ 25 rem/event dose standard with two footnotes, as follows, stating that:

> "In addition to meeting the listed worker and co-located worker dose standards for accidents, the Worker Accident Risk Goal is satisfied through the calculation of the risk from accidents with accident prevention and mitigation features added as necessary to meet the Goal. See Section 2.0 of BNFL-5193-RES-01." and,
>
> "In addition to meeting the listed dose standards for accidents, BNFL's approach to accident mitigation is to evaluate accident consequences to ensure that the calculated exposures are far enough below standards to account for uncertainties in the analysis, and to provide for sufficient design margin and operational flexibility."

The proposed 25 rem/event dose standard is a consequence limit sufficiently low to ensure that the risk to workers and co-located workers from the consequences of accidents would be acceptable. The Contractor's overall approach to accident mitigation and selection of safeguards will provide an adequate level of safety, and its proposed consequence limit is sufficiently low to ensure that radiation exposures to workers and co-located workers as a result of accidents would be ALARA. The proposed standards conform to the applicable top-level standards, provide an adequate level of safety, and ensure that cost-effective safeguards affecting anticipated events are evaluated (and incorporated as appropriate) consistently with the optimization approach embodied by the ALARA principle.

Conclusions

The BNFL SRD adequately incorporate and conform to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, Table 1. BNFL's recommended set of individual standards, when implemented, provide for adequate safety of applicable activities during design, construction, operation, and deactivation. BNFL has provided adequate justification of the appropriateness of the set of individual standards based on considerations of the work activities, associated hazards, and selection of hazards control strategies.

3.2.2 Radiological and Nuclear Safety Objectives

3.2.2.1 General Safety Objectives

Requirements

DOE/RL-96-0003 requires that the SA Package, including the Contractor's recommended set of radiological, nuclear, and process safety standards for design, construction, operation, deactivation, and regulatory submittals, be in the form of an SRD. The Contractor shall certify that the standards set, when implemented, will provide adequate safety, comply with all applicable laws and regulations, and conform to the DOE-stipulated top-level standards and principles contained in DOE/RL-96-0006. DOE/RL-96-0003 also states that the submittal shall consist of the Contractor's treatment of the top-level radiological, nuclear, and process safety standards and principles. The top-level radiological, nuclear, and process safety standards for general safety objectives limit the risk to workers, co-located workers, and the public for normal operation and credible accident conditions. Compliance with these objectives is established, in part, through standards required by DOE/RL-96-0006, Table 1. Pursuant to the DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the documented standards set conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, and will provide adequate safety if properly implemented.

The DOE/RL-96-0006 contains the following general safety objectives in Section 3.1:

- The Operations Risk Goal states: "The risk, to the population (public and workers) in the area of the Contractor's facility, of cancer fatalities that might result from facility operation should not exceed one-tenth of one percent (0.1%) of the sum of cancer fatality risks to which members of the U.S. population generally are exposed." A referenced footnote states that "For evaluation purposes, individuals are assumed to be located within 10 miles of the controlled area."

- The Accident Risk Goal states: "The risk, to an average individual in the vicinity of the Contractor's facility, of prompt fatalities that might result from an accident should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population generally are exposed." A referenced footnote states that "For evaluation purposes, individuals are assumed to be located within one mile of the controlled area."

- The Worker Accident Risk Goal states: “The risk, to workers in the vicinity of the Contractor’s facility, of fatality from radiological exposure that might result from an accident should not be a significant contributor to the overall occupational risk of fatality to workers.” A referenced footnote states that “For evaluation purposes, workers are assumed to be located within the controlled area.”

Review Methodology

The reviewers evaluated the adequacy of the Contractor’s conformance to the top-level radiological, nuclear, and process safety standards and principles of the general safety objectives contained in DOE/RL-96-0006. The information provided by BNFL was assessed to ensure that: the standards set documented in the SRD conforms to the general safety objectives in DOE/RL-96-0006; BNFL’s recommended set of individual standards, when implemented, will provide for adequate safety of applicable activities during design, construction, operation, and deactivation; and BNFL provides adequate justification of the appropriateness of the set of individual standards on the basis of considerations of the work activities, associated hazards, and selection of safeguards.

Conformance to these objectives is established, in part, through the standards required by DOE/RL-96-0006, Table 1. These standards include the radiological dose standards for workers, co-located workers, and the public during normal operation and credible accident conditions. The individual radiological and nuclear standards presented in DOE/RL-96-0006, Table 1, include the human dose standards with which all facility activities of the Contractor involving radiological and nuclear hazards must comply. These standards are consistent with radiological exposure limits embodied by DOE and NRC regulations and with the perspectives of the ICRP and the NCRP.

BNFL was required to provide a regulatory deliverable, the RESW, that addresses and incorporates the top-level standards and principles of DOE/RL-96-0006, Table 1. The deliverable document is the BNFL RESW, dated August 28, 1997. Revisions to this document were provided on December 8 and 17, 1997, as part of the review question and resolution process. Table A of the BNFL submittal corresponds to Table 1 of DOE/RL-96-0006 and is duplicated in Safety Criterion 2.0-1. The BNFL RESW addresses conformance to each of the general safety objectives.

The RU’s evaluation of the adequacy of Contractor conformance is documented in Appendix B of this Evaluation Report. The review was performed using guidance in RL/REG-97-09. This evaluation was conducted through a review of the material presented in the BNFL RESW, the SRD, and the resolution of questions developed in the review process.

Evaluation

The BNFL RESW and sections of the SRD document relevant information on standards that provide conformance to the general safety objectives of DOE/RL-96-0006. The RESW Evaluation Report (Appendix B) provides a detailed evaluation of BNFL’s proposed standards to the Operations, Accident and Worker Accident Risk Goals. The results are summarized below.

The Operations, Accident, and Worker Accident Risk Goals (Top-Level Objectives 3.1.1, 3.1.2, and 3.1.3) are incorporated in SC 1.0-4, 1.0-3, and 1.0-5, respectively. In general, BNFL expresses subordinate (or implementing) standards in the RESW that adequately describe how they will implement the “General Safety Objectives” in the Top-Level Principles.

The standards set conforms to the Operations Risk Goal through the radiation dose and ALARA design standards proposed in the BNFL RESW, Table A, for normal events for the worker, co-located worker, and the public. The radiation dose standards proposed in the BNFL SRD comply with all applicable laws and regulations. For the proposed BNFL facility, airborne effluents are likely to represent the primary pathway for radiation exposure to the public. Applicable regulations restrict the radiation exposure to the public from all airborne effluent sources at the Hanford Site, which would include those from the proposed BNFL facility, to less than or equal to 10 mrem per year. For this reason, the risk to the public from the primary exposure pathway from the BNFL facility will be limited to some fraction of the 10 mrem per year. The selection of standards incorporating the application of an ALARA program to optimized exposures from facility operations is essential for conformance to this goal. The standards set addresses ALARA for both worker activities (Safety Criteria 5.2-1, 5.2-2, and 5.2-3 of BNFL SRD) and effluent releases (Safety Criteria 5.2-4, 5.3-2, 5.3-3, 5.3-4, and 5.3-7). On the basis of an evaluation of the risk to individuals assumed to be located within 10 miles of the controlled area, the BNFL standards set ensures compliance with the Operations Risk Goal (DOE/RL-96-0006, Section 3.1.1). Such assurance provides for adequate safety during normal operation.

The standards set conforms to the Accident Risk Goal through the radiation dose and ALARA design standards proposed in the BNFL RESW, Table A, for credible accident conditions for the worker, co-located worker, and the public. The radiation dose standards proposed by BNFL comply with all applicable laws and regulations and are not greater than 25 rem for any credible accident. Because an acute radiation dose of approximately 100 rem carries almost no risk of prompt death (EH-12-94-01 Vol. 2, *Appendixes*, Appendix B, 1994, p. B-1), it is reasonable to conclude that a worker radiation dose standard of 100 rem would satisfy the goal. BNFL has proposed dose standards that are 25% of this value. On the basis of an evaluation of the risk to individuals assumed to be located within 1 mile of the controlled area, the BNFL standards set ensures compliance with the Accident Risk Goal (DOE/RL-96-0006, Section 3.1.2). Such assurance provides for adequate safety in controlling the risk of prompt fatality during credible accident conditions.

The standards set conforms to the Worker Accident Risk Goal through the radiation dose and ALARA design standards proposed in the BNFL RESW, Table A, for the accident conditions for the worker, co-located worker, and the public. A radiation dose standard not greater than 25 rem has been proposed for accidents in the unlikely (1×10^{-4}/yr to 1×10^{-2}/yr) and extremely unlikely (1×10^{-6}/yr to 1×10^{-4}/yr) event probability ranges. For the unlikely and extremely unlikely events probability range, the Contractor has included additional provisions to ensure conformance to the Worker Accident Risk Goal. As excerpted from Table A, the Contractor states that:

> “In addition to meeting the listed worker and co-located worker dose standards for accidents, the Worker Accident Risk Goal is satisfied through the calculation of the risk from accidents, with accident prevention and mitigation features added as necessary to meet the Goal” and,
>
> “In addition to meeting the listed dose standards for accidents, BNFL’s approach to accident mitigation is to evaluate accident consequences to ensure that the calculated exposures are far enough below standards to account for uncertainties in the analysis, and to provide for sufficient design margin and operational flexibility.”

The proposed 25 rem per event dose standard is a consequence limit sufficiently low to ensure that the risk to workers and co-located workers from the consequences of accidents will be acceptable. The Contractor's overall approach to accident mitigation and selection of safeguards will provide an adequate level of safety, and its proposed consequence limit is sufficiently low to ensure that radiation exposures to workers and co-located workers as a result of accidents would be ALARA. On the basis of an evaluation of the risk to workers assumed to be located within the controlled area, the BNFL standards set ensures compliance with the Worker Accident Risk Goal (DOE/RL-96-0006, Section 3.1.3).

The reviewers concluded that BNFL's overall approach to accident mitigation and selection of safeguards could result in a facility with an associated risk of fatality from radiological exposure that is significantly less than that needed to conform to the DOE-specified top-level standards and principles. The reviewers noted that this extra margin of safety may result in the inclusion of safety systems and components beyond those required for conformance to the top-level standards. However, this would occur only if a single accident were to contribute most of the collective risk for all accidents in the extremely unlikely event probability ranges. This extra margin of safety can be assessed though an evaluation of an extremely low probability event, such as that of frequency of 1×10^{-6} per year. The BNFL dose standards of 25 REM per event for extremely unlikely events equates to a risk of fatality of 2.5×10^{-8}, using a risk factor of 1×10^{-3} fatal cancers per rem recommended in *Health Effects of Exposure to Low Levels of Ionizing Radiation* (BEIR V, Committee on the Biological Effects of Ionizing Radiation, National Academy of Sciences, 1990) for exposures at or above 10 rem, and has been adopted by both the ICRP and NCRP. According to EH-12-94-01, Vol. 1, the risk of fatality to workers in U.S. industries ranges from about 3×10^{-5} in the "safest" industry to 4×10^{-4} in the "least safe" industry. A value of 1×10^{-4} can be considered "average." Using 10% as the threshold for a significant contributor as specified in the Worker Accident Risk Goal, an overall risk of fatalities associated with facility accidents of 1×10^{-5} per year would result in an accident not being considered a significant contributor to the overall occupational risk of fatality to workers. This evaluation is consistent with guidance contained in EH-94-12-01, Vol. 1. The reviewers concluded that the 2.5×10^{-8} fatality per event risk value selected by BNFL is significantly less than the 1.0×10^{-5} value for the risk of fatality per year needed to conform to the Worker Accident Risk Goal. From a safety perspective, this is acceptable.

Conclusions

The proposed standards set limits the risk to workers, co-located workers, and the public from normal operations and credible accident conditions to acceptable levels, thereby ensuring a commitment to adequate safety. BNFL provided adequate justification of the appropriateness of the standards set based on considerations of the work activities, associated hazards, and selection of safeguards.

3.2.2.2 Radiation Protection Objective

Requirements

The DOE/RL-96-0003 requires that the SA Package, including the Contractor's recommended set of radiological, nuclear, and process safety standards for design, construction, operation, deactivation, and regulatory submittals, be in the form of an SRD. The Contractor shall certify that the standards set, when implemented, will provide adequate safety, comply with all applicable laws and regulations, and conform to the DOE-stipulated top-level standards and principles contained in DOE/RL-96-0006. DOE/RL-96-0003 also states that the SRD shall consist of the Contractor's treatment of the top-level radiological, nuclear, and process safety standards and principles. The top-level radiological, nuclear, and process safety standards for the radiation protection objective (DOE/RL-96-0006, Section 3.2) is:

- Radiation Protection Objective (Top-Level Principle 3.2): "Ensure that during normal operation, radiation exposure within the facility and radiation exposure and environmental impact due to any release of radioactive material from the facility is kept as low as is reasonably achievable (ALARA) and within prescribed limits; and ensure mitigation of the extent of radiation exposure and environmental impact due to accidents."

Conformance to this objective is established, in part, through standards required by DOE/RL-96-0006, Table 1. Pursuant to the DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the documented standards set conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, and will provide adequate safety if properly implemented.

<u>Review Methodology</u>

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of the radiation protection objectives contained in DOE/RL-96-0006. The information provided by BNFL was assessed to ensure: the adequacy of the standards set documented in the SRD to conform to the radiation protection objective contained in DOE/RL-96-0006; that BNFL's recommended set of individual standards, when implemented, will provide for adequate safety of applicable activities during design, construction, operation, and deactivation; and that BNFL provides adequate justification of the appropriateness of the set of standards addressing the radiation protection objective, based on considerations of the work activities, associated hazards, and selection of safeguards.

Conformance to the radiation protection objective is established, in part, through the standards required by DOE/RL-96-0006, Table 1. These standards include the radiological dose standards for workers, co-located workers, and the public during normal operation and credible accident conditions. The individual radiological and nuclear standards presented in DOE/RL-96-0006, Table 1, include: (1) the human dose standards with which all facility activities of the Contractor involving radiological and nuclear hazards must comply; and (2) ALARA design standards ensuring the identification and incorporation of cost-effective and feasible safeguards to prevent and mitigate radiological exposures. These standards are consistent with radiological exposure limits embodied by DOE and NRC regulations and the perspectives of the ICRP and the NCRP.

BNFL was required to provide a regulatory deliverable, the BNFL RESW, that addresses and incorporates the top-level standards and principles of DOE/RL-96-0006, Table 1. This document is contained in the BNFL RESW, dated August 28, 1997. Revisions to the BNFL RESW were provided on December 8 and 17, 1997, as part of the review question and resolution process. Table A of the BNFL submittal corresponds to DOE/RL-96-0006 Table 1and is duplicated in Safety Criterion 2.0-1. The BNFL RESW addresses conformance to each of the general safety objectives.

The RU's evaluation of the adequacy of Contractor conformance is documented in Appendix B of this Evaluation Report. The review was performed using guidance in RL/REG-97-09, Rev. 0.

This evaluation was conducted through a review of the material presented in the BNFL RESW, the SRD, and the resolution of questions developed in the review process.

Evaluation

The BNFL RESW and sections of the SRD document relevant information on standards and subordinate standards that provide conformance to the radiation protection objective of DOE/RL-96-0006.

The standards set included in the BNFL SRD conforms to the radiation protection objective through the radiation dose and ALARA design standards proposed in the BNFL RESW, Table A, for the worker, co-located worker, and the public. As documented in this BNFL SRD Evaluation Report, the radiation dose standards proposed by BNFL comply with all applicable laws and regulations. The selection of standards incorporating the application of an ALARA program to optimize exposures from facility operations is essential to conformance to this goal. The standards set addresses ALARA for both worker activities (Safety Criteria 5.2-1, 5.2-2, and 5.2-3 of BNFL SRD Vol. II) and effluent releases (Safety Criteria 5.2-4, 5.3-2, 5.3-3, 5.3-4, and 5.3-7).

The Contractor's overall approach to accident mitigation and selection of safeguards will provide an adequate level of safety if properly implemented. Furthermore, the consequence limit proposed in the BNFL SRD is sufficiently low to ensure that radiation exposure and environmental impact due to accidents will be mitigated. BNFL has proposed a radiation dose standard of 25 rem for accidents in the unlikely (1×10^{-4}/yr to 1×10^{-2}/yr) and extremely unlikely (1×10^{-6}/yr to 1×10^{-4}/yr) event probability ranges. For the unlikely and extremely unlikely events probability ranges, the Contractor has included an additional provision to ensure that the calculated exposures are far enough below standards to account for uncertainties in the analysis, and to provide for sufficient design margin and operational flexibility.

Conclusions

The proposed standards set limits radiation exposure, requires ALARA consideration, and ensures mitigation of the radiological impact of accidents consistent with ensuring adequate safety. BNFL provided adequate justification of the appropriateness of the standards set based on considerations of the work activities, associated hazards, and selection of safeguards.

3.2.2.3 Technical Safety Objectives

Requirements

DOE/RL-96-0003 requires that the SA Package, including the Contractor's recommended set of radiological, nuclear, and process safety standards for design, construction, operation, deactivation, and regulatory submittals, be in the form of an SRD. The Contractor shall certify that the standards set, when implemented, will provide adequate safety, comply with all applicable laws and regulations, and conform to the DOE-stipulated top-level standards and principles contained in DOE/RL-96-0006. DOE/RL-96-0003 also states that the SRD shall consist of the Contractor's treatment of the top-level radiological, nuclear, and process safety standards and principles. Pursuant to the DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the documented standards set conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, and will provide adequate safety if properly implemented.

DOE/RL-96-0006, Section 3.3, “Technical Safety Objectives,” contains the following three top-level principles relating to technical safety objectives:

- Public Protection (Top-Level Principle 3.3.1): “Measures in the design and operation of the facility to protect the public against accident conditions should be evaluated against acceptable guidelines to demonstrate that they perform their intended purpose with high confidence.”

- Worker Protection (Top-Level Principle 3.3.2): “Measures in the design and operation of the facility to protect the workers against accident conditions should be evaluated using an acceptable approach to demonstrate that they perform their intended purpose with high confidence.”

- Accident Vulnerability Mitigation (Top-Level Principle 3.3.3): “Particular care should be taken to identify, evaluate, and prevent and/or mitigate any vulnerabilities to accidents that might, by themselves, result in a release of radioactive material that exceeds acceptable levels.”

<u>Review Methodology</u>

The reviewers evaluated the Contractor’s conformance to the top-level radiological, nuclear, and process safety standards and principles of the technical safety objectives contained in DOE/RL-96-0006. The information provided by BNFL was assessed to ensure that: (1) the Contractor’s proposed standards ensure that measures in the design and operation of the facility to protect the public and the worker against accident conditions are evaluated by the Contractor against acceptable guidelines contained in the selected set of standards; (2) the Contractor’s proposed standards require the Contractor to demonstrate that the design and operational measures perform with a high level of confidence; (3) the Contractor’s set of proposed standards allow the incorporation of a process to identify, evaluate, and prevent and/or mitigate any reasonable vulnerability to an accident; and (4) the technical safety objectives are achievable within the framework of the Contractor’s selected set of proposed standards.

This examination was conducted through review of the material presented in the BNFL SRD, Vol. II, Rev. 0, the *Hazard Analysis Report* (HAR), BNFL-5193-HAR-01, and the resolution of questions developed during the review.

<u>Evaluation</u>

Volume II of the BNFL SRD contains the Contractor’s proposed set of standards. The safety criteria included in these standards are described as follows:

- SC 1.0-6 is a proposed standard that states: “Measures in the design and operation of the facility to protect the public, workers, and environment against accident conditions shall be evaluated using an acceptable approach to demonstrate that they perform their intended purpose with high confidence.”

- SC 1.0-8 is a proposed standard that states: "Structures, systems, and components (SSCs) required to protect the health and safety of the public from unacceptable releases of radionuclides or hazardous material will be designated as 'Design Class I'. The public offsite radiological exposure standards of Safety Criterion 2.0-1, Table 2-1, 'Radiological Dose Standards Above Normal Background,' and the public chemical exposure standard of Safety Criterion 2.0-2 shall be used to identify Design Class I SSCs. SSCs credited for prevention of criticality will also be designated as Design Class I. In general, Design Class I SSCs that protect the health and safety of the public for accident conditions are considered to provide adequate protection to the environment."

- SC 1.0-9 is a proposed standard that states: "Structures, Systems, and Components (SSCs) required to protect the health and safety of workers from unacceptable releases of radionuclides or hazardous material will be designated as 'Design Class II.' The worker radiological exposure standards of Safety Criterion 2.0-1, Table 2-1, 'Radiological Dose Standards Above Normal Background,' and the worker chemical exposure standard of Safety Criterion 2.0-2 shall be used to identify these SSCs." BNFL's Safety Criterion 1.0-8 defines "measures in the design and operation of the facility to protect the public…and environment" referred to in Safety Criterion 1.0-6. Similarly, Safety Criterion 1.0-9 defines "measures in the design to protect workers" referred to in Safety Criterion 1.0-8.

- SC 3.1-4 is a proposed standard which directs that hazard analyses are to: (1) determine the consequences (to persons both onsite and offsite) of unmitigated releases of harmful materials; (2) be based on an inventory of all the harmful materials that are stored, used, or formed in the facility; (3) identify energy sources that might contribute to the generation or uncontrolled release of harmful materials; and (4) evaluate the risks that inventories of hazardous materials and energy sources pose by considering normal operations (including startup, testing, and maintenance), anticipated operational occurrences, and accident conditions. The identification of anticipated operational occurrences and accident conditions shall consider internal events (i.e., equipment failure and human error), external events (e.g., nearby facilities and transportation), and natural phenomena. Safety Criterion 3.1-4 defines what is meant by "particular care to identify, evaluate, and prevent and/or mitigate any vulnerabilities to accidents" in Top-Level Principle 3.3.3.

Conclusions

The reviewers concluded that the proposed safety criteria adequately incorporate and conform to the three Top-Level Principles of the Technical Safety Objective Standard.

3.2.3 Radiological and Nuclear Safety Principles

3.2.3.1 Overall Principles

3.2.3.1.1 Defense in Depth

Requirements

DOE/RL-96-0006, Section 4.1.1, requires that the Contractor apply defense in depth to the design and operation of its TWRS-P facility. Defense in Depth consists of the following six principles with which the Contractor is required to conform :

- Defense in Depth (Top-Level Principle 4.1.1.1): "To compensate for potential human and mechanical failures, a defense-in-depth strategy should be applied to the facility commensurate with the hazards such that assured safety is vested in multiple, independent safety provisions, no one of which is to be relied upon excessively to protect the public, the workers, or the environment. This strategy should be applied to the design and operation of the facility."

- Prevention (Top-Level Principle 4.1.1.2): "Principle emphasis should be placed on the primary means of achieving safety, which is the prevention of accidents, particularly any that could cause an unacceptable release."

- Control (Top-Level Principle 4.1.1.3): "Normal operation, including anticipated operational occurrences, maintenance, and testing, should be controlled so that facility and system variables remain within their operating ranges and the frequency of demands placed on structures, systems, and components important to safety is small."

- Mitigation (Top-Level Principle 4.1.1.4): "The facility should be designed to retain the radioactive material through a conservatively designed confinement system for the entire range of events considered in the design basis. The confinement system should protect the workplace and the environment."

- Automatic Systems (Top-Level Principle 4.1.1.5): "Automatic systems should be provided that would place and maintain the facility in a safe state and limit the potential spread of radioactive materials when operating conditions exceed predetermined safety setpoints."

- Human Aspects (Top-Level Principle 4.1.1.6): "The human aspects of defense in depth should include a design for human factors, a quality assurance program, administrative controls, internal safety reviews, operating limits (Technical Safety Requirements), worker qualification and training, and the establishment of a safety/quality program."

Review Methodology

The reviewers evaluated the safety criteria proposed by the Contractor for the application of defense in depth principles and assessed the safety criteria to the attributes of RL/REG-97-08. To conform to the standards and principles of DOE/RL-96-0006 for defense in depth, the Contractor should:

- Design a program that defines multiple, independent safety provisions which are sufficient for identified hazards and in which no one provision is relied upon excessively to protect the public, the workers or the environment; and

- Describe how defense in depth features will be tailored into the design and operations in a manner commensurate with the identified hazards.

SRD information that the reviewers considered for this assessment is found in Volume I, Section 3.4, "Hazards Control Strategies," and Attachments D and F and SRD Volume II. ISMP information that the reviewers considered for this assessment is found in Section 3.1, "Defense in Depth." ISA information that the reviewers considered for this assessment is found in Chapter 4, "Integrated Safety Analysis" and Appendix 1A, "BNFL Inc. Overall Safety Approach."

Evaluation

The reviewers evaluated BNFL SRD Vol. II that contains the Contractor's proposed set of standards. A description of the safety criteria that address the defense in depth principles and the reviewers evaluation are provided in the following paragraphs.

Defense in Depth, Top-Level Principle 4.1.1.1

BNFL SRD Volume II Safety Criterion 1.0-7 states, "To compensate for potential human and equipment failures, a defense-in-depth strategy shall be applied to the facility commensurate with the hazards; such that, as appropriate to control the risk, safety is vested in multiple, independent safety provisions, no one of which is to be relied upon excessively to protect the public, the workers, or the environment. This strategy shall be applied to the design and operation of the facility."

The reviewers determined that this safety criterion adequately incorporated Top-Level Principle 4.1.1.1. However, BNFL identified no subordinate (implementing) standard for this principle. In correspondence subsequent to the SRD submittal (BNFL letter W338-98-0004 dated February 19, 1998), BNFL provided additional information regarding their planned implementation of defense in depth. In this correspondence BNFL stated that sections of Appendix 1A of the Initial Safety Assessment served as the subordinate standard for defense in depth. The reviewers determined that the ad hoc standard provided in the correspondence was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable section of ISA Appendix 1A into the SRD.

Prevention, Top-Level Principle 4.1.1.2

BNFL SRD Volume II Safety Criterion 1.0-2 states, "Principal emphasis should be placed on the prevention of accidents, particularly any that could cause an unacceptable release, as the primary means of achieving safety."

The reviewers determined that this safety criterion adequately incorporated Top-Level Principle 4.1.1.2. However, BNFL identified no subordinate (implementing) standard for this principle. In correspondence subsequent to the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for prevention. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for prevention. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Control, Top-Level Principle 4.1.1.3

BNFL SRD Volume II Safety Criterion 7.0-2 states, "Normal operation, including anticipated operational occurrences, maintenance, and testing, shall be controlled so that facility and system variables remain within their normal operating ranges and the frequency of demands placed on Design Class II structures, systems, and components is small."

The reviewers determined that this safety criterion did not adequately incorporate Top-Level Principle 4.1.1.3. SC 7.0-2 only addressed Design Class II components and not all components important to safety. Additionally, BNFL did not identify an implementing standard for this principle. In subsequent correspondence (BNFL letter W338-98-0004 dated February 19, 1998), BNFL stated that the subordinate (implementing) standard was included in Appendix 1A of the Initial Safety Assessment (ISA). The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of Appendix 1A of the ISA into the SRD.

Mitigation, Top-Level Principle 4.1.1.4

BNFL SRD Volume II Safety Criterion 4.2-1 states, "The facility shall be designed to retain the radioactive material through a conservatively designed confinement system for normal operations, anticipated operational occurrences, and accident conditions. The confinement system shall protect the worker and public from undue risk of releases such that the radiological and chemical exposure standards of Safety Criteria 2.0-1 and/or 2.0-2 are not exceeded."

The reviewers determined that this safety criterion adequately incorporated Top-Level Principle 4.1.1.3. However, BNFL identified no subordinate (implementing) standard for this principle. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for mitigation. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for mitigation. The reviewers determined that this ad hoc standard was an adequate subordinate standard for mitigation; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Automatic Systems, Top-Level Principle 4.1.1.5

BNFL SRD Volume II Safety Criterion 4.3-1 states, "Engineered safety systems shall be designed (1) to initiate automatically the operation of appropriate systems to assure that specified acceptable design limits are not exceeded as a result of anticipated operational occurrences and (2) to sense accident conditions and to initiate the operation of systems and components designated as Design Class I. The ability to manually initiate engineered safety systems shall be provided."

The reviewers determined that this safety criterion did not adequately incorporated Top-Level Principle 4.1.1.5. This safety criteria is excessively restrictive in that it limits itself to engineered safety systems that are categorized as Design Class I and not all equipment that is important to safety. The reviewers determined that the subordinate standards that BNFL identified, IEEE 603-91 and ISA S84.01-96, were adequate for this principle.

Human Aspect, Top-Level Principle 4.1.1.6

BNFL established a number of safety criteria to incorporate this top-level principle into their safety standards. The following safety criteria incorporate the human aspects of defense in depth:

- SC 4.3-6: "The possibility of human error in facility operations shall be taken into account in the design by facilitating correct decisions by operators and inhibiting wrong decisions and by providing means for detecting and correcting or compensating for error. The parameters to be monitored in control areas shall be selected and their displays arranged to ensure operators have clear and unambiguous indication of the status of the facility. The parameters and displays shall facilitate monitoring and the initiation and operation of systems designated as Design Class I or Design Class II."

- SC 7.3-2: "A written Quality Assurance Program (QAP) shall be developed, implemented, and maintained. The QAP shall describe the organizational structure, functional responsibilities, levels of authority, and interfaces for those managing, performing, and assessing the work. The QAP shall describe management processes, including planning, scheduling, and resource considerations."

- SC 7.3-5: "Work shall be performed to established technical standards and administrative controls using approved instructions, procedures, or other appropriate means. Items shall be identified and controlled to ensure their proper use. Items shall be maintained to prevent their damage, loss, or deterioration. Equipment used for process monitoring or data collection shall be calibrated and maintained."

- SC 7.1-3: "A framework shall be established for safety review organizations that are responsible for assuring the safety of the facility. The separation between the responsibilities of the safety review organizations and those of the other organizations shall remain clear so that the safety review organizations retain their independence as safety authorities. Internal safety oversight should be conducted by qualified personnel to ensure that the safety standards are consistently met."

- SC 9.2-1: "Technical safety requirements shall be prepared and submitted for approval, and the facility shall be operated in accordance with the approved technical safety requirements."

- SC7.2-1: "Programs providing for continual training and qualification for operations, maintenance, and technical support personnel, to enable them to perform their duties safely and efficiently shall be developed and implemented utilizing a tailored approach."

The reviewers determined that these safety criteria adequately incorporated the top-level principle for human aspects of defense in depth. However, BNFL identified no subordinate (implementing) standards for this principle. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding the subordinate standard for human aspects. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for human aspects. The reviewers determined that these ad hoc standards were adequate subordinate standards for human aspects; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Conclusions

In general, the BNFL safety approach by applying human factor considerations to defense in depth is acceptable. However, SC 4.3-1 and SC 7.0-2 do not adequately incorporate Top-Level Principles 4.1.1.5 and 4.1.13, respectively. These safety criteria must be modified to include all equipment important to safety instead of Design Class I and II, respectively. Additionally, the BNFL SRD did not include subordinate standards for all the above mentioned safety criteria with the exception of SC 4.3-1. BNFL must include adequate subordinate standards in the SRD for the aforementioned Safety Criteria.

3.2.3.1.2 Safety Responsibility

Requirements

DOE/RL-96-0006, Section 4.1.2, requires that the standards and requirements identified and recommended by the Contractor address the overall principle of safety responsibility that includes the following four top-level principles:

- Safety Responsibility (Top-Level Principle 4.1.2.1): “Ultimate responsibility for the safety of the facility rests with the Contractor. In no way should this responsibility be diluted by the separate activities and responsibilities of designers, suppliers, constructors, the Regulatory Unit, or independent oversight bodies.”

- Safety Assignments (Top-Level Principle 4.1.2.2): “The assignment and subdivision of responsibility for safety should be kept well defined throughout the life of the facility.”

- Site and Technical Support (Top-Level Principle 4.1.2.3): “The Contractor should assure commitments from relevant parties to provide data and services needed to fulfill its safety commitments.”

- Operating Experience and Safety Research (Top-Level Principle 4.1.2.4): “Operating experience and the results of research relevant to safety should be obtained, reviewed, and analyzed, and lessons that are learned should be implemented in the design, construction or modification, and operation of the facility.”

Pursuant to DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, (including the overall safety responsibility principle required by Section 4.1.2 of DOE/RL-96-0006).

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of safety responsibility contained in DOE/RL-96-0006. The information provided by BNFL was assessed to: (1) determine the compatibility of BNFL's standards with the overall safety responsibility principle, and (2) ensure that the overall safety responsibility principle is incorporated into the BNFL SRD. This examination was conducted through review of the material presented in the BNFL SRD.

Evaluation

The BNFL SRD, Vol. I, Attachment E, "Compliance With Applicable Laws and Contract Requirements" references six safety criteria contained in Vol. II of the BNFL SRD. These safety criteria address the overall safety responsibility principle (see DOE/RL-96-0006, Section 4.1.2). The SRD, Attachment F, "Mapping of RL/REG-97-08 Attributes," provides a tabular summary which indicates that Section 2.1.1 of the BNFL Initial Safety Assessment Report (ISAR) will contain information regarding the overall safety responsibility principle. Measures to ensure implementation of the overall safety responsibility principle are described in the BNFL ISMP and are addressed in the BNFL ISMP Evaluation Report, Section 3.2.2.2.

As described in the following paragraphs, the reviewers examined the safety criteria referenced in the SRD and compared them to the requirements of DOE/RL-96-0006, Section 4.1.2.

Safety Responsibility, Top-Level Principle 4.1.2.1

BNFL SRD Vol. II Safety Criterion 7.0-1 states "Normal operations shall be conducted in accordance with approved operational safety requirements and in strict accordance with administrative and procedural controls," and SC 7.1-3 states, "A framework shall be established for safety review organizations that are responsible for assuring the safety of the facility. The separation between the responsibilities of the safety review organizations and those of the other organizations shall remain clear so that the safety review organizations retain their independence as safety authorities. Internal safety oversight should be conducted by qualified personnel to ensure that the safety standards are consistently met."

The reviewers determined that these safety criteria do not adequately incorporate and conform to this principle because the safety criteria do not state that BNFL Inc. assumed "ultimate responsibility" for safety of the facility as required to conform to the principle. Additionally, the issue of full safety responsibility (ultimate responsibility) is further brought into questioned by the proposed formation of a "limited liability corporation." In correspondence subsequent to the SRD submittal (BNFL letter W338-98-0004 dated February 19, 1998), BNFL provided additional information regarding their responsibility for safety. In this correspondence BNFL stated that, "… we take full ownership and responsibility for the safety of the workers and the public." The reviewers determined that BNFL must further clarify this important issue. Subordinate (implementing) standards were not identified for the related safety criteria.

Safety Assignments, Top-Level Principle 4.1.2.2

BNFL SRD Vol. II Safety Criterion 7.0-4, states, "The assignment and subdivision of responsibility for safety within the contractor's organization shall be kept well defined throughout the life of the facility."

The reviewers determined that these safety criteria adequately incorporated the top-level principle for safety assignments. However, subordinate (implementing) standards were not identified for these safety criteria. In correspondence subsequent to the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for safety assignments. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for safety assignments. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Site and Technical Support, Top-Level Principle 4.1.2.3

BNFL SRD Vol. II Safety Criterion 7.1-4 states, "Commitments from outside organizations to provide data and services required to satisfy safety obligations shall be made prior to the need for the information or services." Also Safety Criterion 7.8-2 states, "The Emergency Management Program will be documented in an emergency plan which describes the provisions for responses to Operational Emergencies. The emergency response plan will address the following program elements…" Collectively, these safety criteria adequately incorporate and conform to this principle. However, BNFL identified no subordinate (implementing) standard for this principle.

Operating Experience and Safety Research, Top-Level Principle 4.1.2.4

BNFL SRD Vol. II Safety Criterion 4.1-2, in part, states, "…Safety technologies incorporated into the facility design should have been proven by experience or testing and should be reflected in approved codes and standards. Significant new design features should be introduced only after thorough research and model or prototype testing at the component, system, or facility level, as appropriate, to achieve the necessary level of confidence that the design feature will perform as expected." While many subordinate (implementing) standards were identified for this safety criterion, none directly related to Top-Level Principle 4.1.2.4. In correspondence subsequent to the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for operating experience and safety research. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for operating experience and safety research. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Conclusions

The reviewers determined that the BNFL SRD adequately incorporates and conforms to three of the four principles of "Safety Responsibility." BNFL did not adequately incorporate or conform to Top-Level Principle 4.1.2.1, "Safety Responsibility," because a safety criterion has not been proposed which clearly states that BNFL Inc. has ultimate responsibility for the safety of the facility. Additionally, BNFL must incorporate, by reference, the applicable sections of the ISMP into the SRD as subordinate standards for the aforementioned safety criteria.

3.2.3.1.3 Authorization Basis

Requirements

DOE/RL-96-0003 requires that the SA Package, including the Contractor's recommended set of radiological, nuclear, and process safety standards for design, construction, operation, and deactivation, and regulatory submittals, be in the form of an SRD. Pursuant to DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the documented standards set conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, Revision 0.

DOE/RL-96-0006 stipulates that the Contractor shall employ the top-level radiological, nuclear standards, and principles in two ways. First, the Contractor must address these top-level standards and principles in the standards and requirements identified and recommended by the Contractor. Second, the Contractor shall incorporate the top-level radiological, nuclear, and process safety standards and principles into the recommended standards and requirements.

DOE/RL-96-0006, Section 4.1.3, "Authorization Basis," states that "Material that is part of the authorization basis should be established, documented, and submitted to the Director of the Regulatory Unit for evaluation and in support of authorization decisions and regulatory oversight. During operations, the Contractor should maintain the material current with the conditions at the facility and in the light of significantly new safety information. This material should include the set of Contractor-recommended standards and requirements; safety analysis; design specifications and drawings; Technical Safety Requirements (TSRs) related to all structures, systems, and components important to safety; and all other materials upon which the Director of the Regulatory Unit grants authorization to proceed to construction, operation, or deactivation; or conducts regulatory oversight."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of the authorization basis (Section 4.1.3) contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: (1) determine the compatibility of BNFL's standards with the authorization basis principle, and (2) ensure that the authorization basis principle is incorporated into the BNFL SRD. This examination was conducted through review of the material presented in the BNFL SRD and the BNFL ISMP.

Evaluation

The authorization basis principle identifies the requirements to establish, document, and submit material to the RU for evaluation and in support of authorization decisions and regulatory oversight. It further identifies requirements to maintain the authorization basis current and available. The authorization basis principle also identifies the expected content of the authorization basis.

During the review of the Contractor's authorization basis safety management process described in the ISMP, the reviewers identified some issues related to the Contractor's approach. As a result of issues pertinent to both of the TWRS-P Contractors, the RU developed RL/REG-97-13, "Regulatory Unit Position on Contractor Intended Changes to the Authorization Basis," to provide a detailed description to the TWRS-P Contractors of the issues associated with managing changes to the authorization basis, and the RU position taken in response to these issues.

To illustrate the authorization basis principle, the safety criteria in the BNFL SRD, Vol. II, Sections 9.1, "Safety Analysis," and 9.2, "Technical Safety Requirements," in SRD Vol. I, Attachment E are referenced. The BNFL SRD also references the ISMP, Section 3.3, "Licensing Basis," in the SRD, Vol. I, Attachment F. The safety criteria (SC) are as follows.

- SC 9.1-1 commits to develop and evaluate the adequacy of the licensing basis and to prepare and document the safety analysis in a Preliminary Safety Analysis Report (PSAR) and a Final Safety Analysis Report (FSAR).

- SC 9.1-2 identifies the topics to be addressed in the safety analysis reports (SAR).

- SC 9.1-3 commits to submit the PSAR and FSAR to the regulator and identifies the conditions to be satisfied by each.

- SC 9.1-4 commits to review the FSAR annually and update it as necessary. A process for addressing unresolved safety questions (USQs) is included. The content of the SAR identified in SC 9.1-2 includes facility and process descriptions, integrated safety analysis, technical safety requirements (TSRs), and several other safety topics.

- SC 9.2-1 commits to prepare, and submit for approval, technical safety requirements (TSRs), and to operate in accordance with the approved TSRs. Related SCs 9.2-2 through 9.2-5 commit to base the TSRs on the FSAR and on the facility.

ISMP Section 3.3 states that "the licensing basis is similar to the authorization basis." ISMP Section 3.3.1, "Content of the Licensing Basis," describes the content of the licensing basis as follows:

- Integrated Safety Management Plan
- Safety Requirements Document
- Safety Analysis Reports
- Technical Safety Requirements
- Quality Assurance Program
- Radiation Protection Program
- Emergency Plan
- Other Information.

ISMP Sections 1.3.16 and 5.3, "Configuration Management," provides additional information on Control of the Licensing Basis.

The reviewers determined that collectively these safety criteria adequately incorporated and conform to this principle. However, BNFL identified no subordinate standards for this principle. In correspondence subsequent to the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding the subordinate standards for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for operating experience and safety research. The reviewers determined that this ad hoc standard, the referenced section of the ISMP, was not an adequate subordinate standard because of insufficient detail in the management of the authorization basis.

Conclusions

The reviewers concluded that the aforementioned SRD safety criteria adequately incorporated and conform to this Top-Level Principle. However, BNFL did not provide subordinate standards for this principle. Additionally, the BNFL SRD is uniquely dependent on the ISMP to fully clarify the content of the authorization basis and to effectively equate the authorization basis to the licensing basis referenced in the SRD and the ISMP. The reviewers concluded that BNFL must provide subordinate standards that reflect the ISMP commitment and clarify the content of the authorization basis and to equate the authorization basis t the licensing basis referenced in the SRD and the ISMP.

3.2.3.1.4 Safety/Quality Culture

Requirements

DOE/RL-96-0006, Section 4.1.4.1, “Safety/Quality Culture,” states that, “A safety/quality program should be established that governs the Contractor's actions and interactions of all personnel and organizations engaged in activities related to the facility and emphasizes excellence in all activities.” Pursuant to DOE/RL-96-0006 and in order to approve the SRD, the RO must make a final determination that the set of standards documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, Revision 0 (including the overall safety/quality culture principle required by Section 4.1.4 of DOE/RL-96-0006).

Review Methodology

The reviewers evaluated the adequacy of the Contractor’s conformance to the top-level radiological, nuclear, and process safety standards and principles of the overall safety/quality culture contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: (1) determine the compatibility of BNFL’s standards with the overall safety/quality culture principle, and (2) ensure that the overall safety/quality culture principle is incorporated into the BNFL SRD. This examination was conducted through review of the material presented in the BNFL SRD.

Evaluation

The BNFL SRD, Vol. I, Attachment E, “Compliance With Applicable Laws and Contract Requirements,” references three safety criteria contained in Vol. II of the BNFL SRD. These safety criteria address the overall safety/quality culture principle (see DOE/RL-96-0006, Section 4.1.4). The SRD, Attachment F, “Mapping of RL/REG-97-08 Attributes,” provides a tabular summary which indicates that the subject of safety/quality culture will be discussed in the BNFL ISAR, Section 2.1. Measures to ensure implementation of the overall safety/quality culture principle are described in the BNFL ISMP and are addressed in the ISMP Evaluation Report, Section 4.2.2.1.4.

The reviewers examined the safety criteria referenced in the BNFL SRD, Vol. I, Attachment E (SC 7.1-3 in Section 7.1 of Vol. II and SCs 7.3-2 and 7.3-6 in Section 7.3 of Vol. II), and compared them to the requirements of DOE/RL-96-0006, Section 4.1.4. On the basis of this comparison, the reviewers determined that these safety criteria adequately incorporated and conform to this principle. Additionally, the reviewers determined that selected safety criteria were adequate subordinate standards for this principle.

Conclusions

The reviewers concluded that the BNFL set of standards conforms to the safety/quality culture principle contained in DOE/RL-96-0006 and is adequate.

3.2.3.1.5 Configuration Management

Requirements

DOE/RL-96-0003 requires that the standards and requirements identified and recommended by the Contractor address the overall principle of configuration management. Pursuant to DOE/RL-96-0006, and in order to approve the SRD, the RO must make a final determination that the set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, Revision 0 (including the overall configuration management principle required by Section 4.1.5 of DOE/RL-96-0006). Configuration Management includes the following three top-level principles with which the Contractor is required to conform:

- Formal Configuration Management (Top-Level Principle 4.1.5.1): “Formal configuration management should be applied to all facility activities during the program’s lifetime to ensure that programmatic objectives, including safety, are fully achieved. Work should be performed and controlled according to pre-approved plans and procedures that clearly delineate responsibilities. Documented records should be retained.”

- Contractor Design Knowledge (Top-Level Principle 4.1.5.2): “The Contractor operating organizations should become and remain familiar with the features and limitations of components included in the design of the facility. They should obtain appropriate input from the design organization on pre-operational testing, operating procedures, and the planning and conduct of training.”

- Design Documentation (Top-Level Principle 4.1.5.3): “A system should be used to control and maintain accurate as-built drawings during the life of the facility.”

Review Methodology

The reviewers evaluated the adequacy of the Contractor’s conformance to the top-level radiological, nuclear, and process safety standards and principles of configuration management contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: (1) determine the compatibility of BNFL’s standards with the overall configuration management principle, and (2) ensure that the overall configuration management principle is incorporated into the BNFL SRD. This examination was conducted through review of the material presented in the BNFL SRD.

Evaluation

The BNFL SRD, Vol. I, Attachment E, references four safety criteria contained in Vol. II of the SRD. These safety criteria address the configuration management principles of DOE/RL-96-0006. Section 3.6, “Maintenance of the SRD” commits to providing additional detail on the configuration management process in the ISAR, Section 3.1, “Configuration Management.” Measures to ensure implementation of the overall configuration management principle are described in the BNFL ISMP and are addressed in the BNFL ISMP Evaluation Report, Section 4.2.2.1.5.

The reviewers examined the safety criteria referenced in the SRD, Attachment E, and compared them to the requirements of DOE/RL-96-0006, Section 4.1.5.

Formal Configuration Management, Top-Level Principle 4.1.5.1

BNFL SRD Volume II Safety Criterion 4.0-1 states, “Formal configuration management shall be applied to all facility activities through deactivation of the TWRS-P facility to ensure that programmatic objectives, including safety, are fully achieved. Work shall be performed and controlled according to pre-approved plans and procedures that clearly delineate responsibility. Documented records shall be retained.”

The reviewers determined that SC 4.0.1 adequately incorporates and conforms to Top-Level Principle 4.1.5.1 because the safety criterion addresses all aspects of the principle. Additionally, the reviewers determined that SC 4.0.2, which describes the implementation of this principle, is an adequate subordinate standard for this principle.

Contractor Design Knowledge, Top-Level Principle 4.1.5.2

BNFL SRD Volume II Safety Criterion 7.0-3 states, “The operating organizations shall become and remain familiar with the features and limitations of components included in the design of the facility. They shall obtain appropriate input from the design organization on pre-operational testing, operating procedures, and the planning and conduct of training.”

The reviewers determined that SC 7.0.3 adequately incorporates and conforms to Top-Level Principle 4.1.5.2 because the safety criterion addresses all aspects of the principle. Additionally, the reviewers determined that SC 7.2.2, which describes the implementation of this principle, is an adequate subordinate standard.

Design Documentation, Top-Level Principle 4.1.5.3

BNFL SRD Volume II Safety Criterion 4.0-3 states, “A system should be used to control and maintain accurate as-built records for Design Class I and Design Class II SSCs through deactivation of the facility.”

The reviewers determined that SC 4.0.3 adequately incorporates and conforms to Top-Level Principle 4.1.5.2 because the safety criterion addresses all aspects of the principle. Additionally, the reviewers determined that SC 4.0.2, which describes the implementation of this principle, is an adequate subordinate standard.

Conclusions

The reviewers concluded that the aforementioned BNFL safety criteria adequately incorporate and conform to the “Configuration Management” principles of DOE/RL-06-0006.

3.2.3.1.6 Quality Assurance

Requirements

DOE/RL-96-0006, Section 4.1.6, contains three top-level principles relating to quality assurance. The principles are defined as follows.

- Quality Assurance Application (Top-Level Principle 4.1.6.1): “Quality assurance and quality control should be applied throughout all phases and to all activities associated with the facility as part of a comprehensive system to ensure with high confidence that all items delivered and services and tasks performed meet required standards.”

- Established Techniques and Procedures (Top-Level Principle 4.1.6.2): “The Contractor should use well proven and established techniques and procedures supported by quality assurance practices to provide high quality equipment and achieve high quality construction.”

- Operational Quality Assurance Programs (Top-Level Principle 4.1.6.3): “Operational quality assurance and control programs should be established by the Contractor to assist in ensuring satisfactory performance in facility activities important to safety.”

Pursuant to the DOE/RL-96-0003, and in order to approve the SRD, the RO must make a determination that the set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, Revision 0 (including the overall quality assurance principle required by Section 4.1.6 of DOE/RL-96-0006).

Review Methodology

The reviewers evaluated the adequacy of the Contractor’s conformance to the top-level radiological, nuclear, and process safety standards and principles of quality assurance contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: (1) determine the compatibility of BNFL’s standards with the overall quality assurance principle, and (2) ensure that the overall quality assurance principle is incorporated into the BNFL SRD. This examination was conducted through review of the material presented in the BNFL SRD.

Evaluation

The BNFL SRD, Vol. I, Attachment E, “Compliance With Applicable Laws and Contract Requirements,” references four safety criteria contained in Vol. II. These safety criteria address the overall quality assurance principle (see DOE/RL-96-0006, Section 4.1.6). The SRD, Attachment F, “Mapping of RL/REG-97-08 Attributes,” provides a tabular summary which indicates that Section 3.3 of the BNFL ISAR will contain information regarding the overall quality assurance principle. Measures to ensure implementation of the overall quality assurance principle are described in the BNFL ISMP and are addressed in the ISMP Evaluation Report, Section 4.2.2.1.6.

The reviewers examined the safety criteria referenced in the SRD, Attachment E, and compared them to the requirements of DOE/RL-96-0006, Section 4.1.6. The safety criteria are as follows:

- SC 7.3-1 in Section 7.3 of Vol. II of the BNFL SRD, regarding the requirements of DOE/RL-96-0006, Section 4.1.6.1
- SC 4.1-2 in Section 4.1 and SC 7.3-1 in Section 7.3 of Vol. II of the BNFL SRD, regarding the requirements of DOE/RL-96-0006, Section 4.1.6.2
- SC 7.3-5 in Section 7.3 of Vol. II of the BNFL SRD, regarding the requirements of DOE/RL-96-0006, Section 4.1.6.3.

On the basis of this comparison and the evaluation performed by the reviewers regarding BNFL's compliance with 10 CFR 830.120 (see Section 3.1.2 of this SRD Evaluation Report), the reviewers determined that the overall quality assurance principle adequately incorporates and conforms to the three "Quality Assurance" Top-Level Principles. Additionally, the other safety criteria of BNFL SRD, Vol. II, Section 7.3, "Quality Assurance," provide adequate subordinate standards to describe the implementation of these principles.

Conclusions

The reviewers concluded that the aforementioned BNFL safety criteria adequately incorporate and conform to the "Quality Assurance" principles of DOE/RL-06-0006.

3.2.3.2 Design, Construction and Pre-Operational Testing

3.2.3.2.1 Design

Requirements

DOE/RL-96-0003 states that the approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the RO that: "(2) The set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in the DOE-provided document titled *Top-level Radiological, Nuclear, and Process Standards and Principles for TWRS Privatization Contractors*, DOE/RL-96-0006, Revision 0."

DOE/RL-96-0006, Section 4.2.1, contains three top-level principles relating to design: The principles are defined as follows:

- Safety Design (Top-Level Principle 4.2.1.1): "The facility should be designed for a set of events such as, normal operation, including anticipated operational occurrences; maintenance and testing; external events; and postulated accidents."
- Risk Assessment (Top-Level Principle 4.2.1.2): "Acceptable risk analyses should be applied during the design to delineate provisions for the prevention and mitigation, including emergency preparedness and response, of otherwise risk-dominant events."

- Safety Analysis (Top-Level Principle 4.2.1.3): "A safety analysis should be performed as required to evaluate the safety performance of the design and identify requirements for operations."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of design contained in DOE/RL-06-0006. The information provided by BNFL was assessed to the following attributes: (1) the principles listed in DOE/RL-96-0006, Section 4.2, "Design, Construction, and Pre-Operational Testing" are tied directly to the design of the Contractor's facility; and (2) these principles are part of the Contractor's design process, and the selected standards used in the design are compatible with utilization of the stated principles. This examination was conducted through review of the material presented in the BNFL SRD and the HAR, and the resolution of questions developed during the review.

Evaluation

The BNFL SRD, Vol. II contains the Contractor's proposed set of standards. Detailed descriptions of the safety criteria proposed by BNFL (SC 4.1-1, SC 3.1-4, SC 3.2-1, SC 9.1-1) are provided in the following paragraphs.

SC 4.1-1 is a proposed standard that states: "The facility design shall provide for the prevention and mitigation of the risks associated with radiological and chemical material inventories and energy sources. The facility design shall include consideration of normal operation (including startup, testing and maintenance), anticipated operational occurrences, and accident conditions. Prevention shall be the preferred means of achieving safety. Defense in depth shall be applied commensurate with the hazard to provide multiple physical and administrative barriers against undue radiation and chemical exposure to the workers and public." This safety criterion establishes the concepts of prevention and defense in depth.

SC 3.1-4 is a proposed standard that comprises four elements. Elements (1), (2), and (3) require that (1) a hazard analysis be conducted to evaluate consequences of unmitigated releases of radioactive and/or highly hazardous chemicals; (2) the hazard analysis shall be based on an inventory of radioactive and hazardous nonradioactive materials that are stored or utilized, or that may be formed within the facility; and (3) the hazard analysis shall identify energy sources or processes that might contribute to the generation of uncontrolled release of radioactive or highly hazardous non-radioactive materials. The requirement for acceptable risk analyses in Top-Level Principle 4.2.1.2 is captured by items (4) and (5):

- (4) The fourth element of SC 3.1-4 states: "The risks that hazardous inventories and energy sources present shall be evaluated by consideration of normal operation (including startup, testing and maintenance), anticipated operational occurrences, and accident conditions"

- (5) SC 3.2-1 states: "Acceptable risk analyses shall be applied during the design to delineate provisions for the prevention and mitigation, including emergency preparedness and response, of otherwise risk-dominant events."

In response to Question 14, the Contractor committed to revise SC 3.1-4 so that hazard analyses will be required for process operations involving hazardous chemicals, not merely for processes involving ”highly hazardous” chemicals, as defined in 29 CFR 1910.119, Appendix A, for a certain subset of hazardous chemicals. Therefore, the reviewers determined that the above safety criteria incorporated all aspects of Top-Level Principles 4.2.1.1, 4.2.1.2 and 4.2.1.3 and conform to those principles.

SC 9.1-1 is a proposed standard that states: “Safety analyses shall be performed using a tailored approach to develop and evaluate the adequacy of the licensing basis for the facility. A PSAR and an FSAR shall be prepared to document the safety analyses.” This incorporates the concept of tailoring into the safety analysis effort.

The RU Review Team determined that the hazard analysis presented in the BNFL SRD is adequate. It sufficiently identifies the hazards and hazardous situations (potential accidents), provides qualitative accident consequences, and proposes suites of potential hazard controls in a manner consistent with Top-Level Principle 4.2.1, “Design,” and to a degree consistent with the preliminary nature of the facility and process designs.

<u>Conclusions</u>

The reviewers concluded that the aforementioned BNFL safety criteria adequately incorporate and conform to the three top-level principles for “Design.” Additionally, the reviewers determined that the safety criteria provided adequate detail on implementation so that no additional subordinate standards are required.

3.2.3.2.2 Proven Engineering Practices/Margins

<u>Requirements</u>

DOE/RL-96-0003 states that the approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the RO that: “2) The set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in the DOE-provided document titled *Top-level Radiological, Nuclear, and Process Standards and Principles for TWRS Privatization Contractors*, DOE/RL-96-0006, Revision 0.”

DOE/RL-96-0006, Section 4.2.2, contains five top-level principles relating to proven engineering practices/margins. The principles are defined as follows:

- Proven Engineering Practices (Top-Level Principle 4.2.2.1): “Safety technologies incorporated into the facility design should have been proven by experience or testing and should be reflected in approved codes and standards. Significant new design features should be introduced only after thorough research and model or prototype testing at the component, system, or facility level, as appropriate.”

- Common-Mode/Common-Cause Failure (Top-Level Principle 4.2.2.2): “Design provisions should be included to limit the loss of safety functions due to damage to several structures, systems, or components important to safety resulting from a common-cause or common-mode failure.”

- Safety System Design and Qualification, (Top-Level Principle 4.2.2.3): "SSCs important to safety should be designed and qualified to function as intended in the environments associated with the events to which they are intended to respond. The effects of aging on normal and abnormal functioning should be considered in design and qualification."

- Codes and Standards (Top-Level Principle 4.2.2.4): "Codes and standards for vessels and piping should be supplemented by additional measures (such as erosion/corrosion programs and in-service inspections of piping) to mitigate conditions that could lead to an unacceptable release of radioactivity during the operational life of the facility."

- Criticality (Top-Level Principle 4.2.2.5): "The facility should be designed and operated in a manner that prevents nuclear criticality."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of design contained in DOE/RL-06-0006. The information provided by BNFL was assessed to the following attributes: (1) The principles listed in DOE/RL-96-0006, Section 4.2, "Design, Construction, and Pre-Operational Testing," are tied directly to the design of the Contractor's facility; and (2) these principles are part of the Contractor's design process, and the selected standards used in the design are compatible with utilization of the stated principles. This examination was conducted through review of the material presented in the BNFL SRD, Vol. II, and the BNFL HAR, Rev. 0, and the resolution of questions developed during the review.

Evaluation

The following sections discuss the evaluation of BNFL SRD Vol. II Safety Criteria and their incorporation and conformance to the five top-level principles of "Proven Engineering Practices and Margins."

Proven Engineering Practices, Top-Level Principle 4.2.2.1

BNFL SRD Vol. II Safety Criterion 4.1-2 states, in part, "Safety technologies incorporated into the facility design should have been proven by experience or testing and should be reflected in approved codes and standards. Significant new design features should be introduced only after thorough research and model or prototype testing at the component, system, or facility level, as appropriate, to achieve the necessary level of confidence that the design feature will perform as expected."

The reviewers determined that SC 4.1-2 adequately incorporates and conforms to Top-Level Principle 4.1.5.2 because the safety criterion addresses all aspects of the principle. Additionally, the reviewers determined that the implementing codes and standards (ACI 318-95, ACI 318R-95, ACI 349-90, ACI 349R-90, AISC MO16-89, AISC N690-95, ASCE 4-86, ASCE 7-95, DOE-STD 1020-94 [Change 1, 1996], DOE-STD-1021-93 [Change 1, 1996], and UBC-94) of this safety criterion are adequate subordinate standards.

Common-Mode/Common-Cause Failure, Top-Level Principle 4.2.2.2

BNFL SRD Vol. II indicates that Safety Criteria 4.1-3, 4.1-4 and 4.3-3 collectively incorporate and conform to this principle. The reviewers determined that that these safety criteria do not address all the aspects of this principle. Therefore, these safety criteria do not conform to the top-level principle for Common-Mode and Common-Cause Failure. Specifically, these criteria only address the effect of natural phenomenon and hazards and not all categories of potential hazards. Additionally, the criteria address only Design Class I and Design Class II SSCs and not all SSCs important to safety. The reviewers determined that the implementing codes and standards (ACI 349-90, ACI 349R-90, AISC N690-95, ASCE 4-86, ASCE 7-95, DOE-STD 1020-94 [Change 1, 1996], DOE-STD-1021-93 [(Change 1, 1996], IEEE 344-87 [Rev. 1993], and UBC-94) of these safety criteria are adequate subordinate standards.

Safety System Design and Qualification, Top-Level Principle Section 4.2.2.3

Safety Criterion 4.4-2 is the proposed standard for the design and qualification of electrical and mechanical systems and components designated (by BNFL) as Design Class I (for protection of the public). The safety criterion requires consideration of the effects of aging on normal and abnormal functions, and states: "Margins must be applied to account for unquantified uncertainty, such as the effects of production variations and inaccuracies in test instruments. These margins are in addition to any conservatisms applied during the derivation of local environmental conditions of the equipment unless these conservatisms can be quantified and shown to contain appropriate margins." The standard IEEE 323-84 is adopted to implement this safety criterion.

The reviewers determined that Safety Criterion 4.4-2 did not adequately incorporate and conform to this Top-Level Principle because the principle applies to <u>all</u> SSC, not just mechanical and electrical equipment, and to important to safety SSCs, not just Design Class I. The codes and standards selected to implement this principle were adequate as subordinate standards.

Codes and Standards, Top-Level Principle 4.2.2.4

BNFL SRD, Vol. II Safety Criterion 4.2-3 states, "Codes and standards for vessels and piping should be supplemented by additional measures (such as erosion/corrosion programs and piping in-service inspections) to mitigate conditions arising that could lead to a release of radiological or chemical material that would exceed the worker or public exposure standards of Safety Criteria 2.0-1 and/or 2.0-2."

The reviewers determined that SC 4.2-3 incorporates and conforms to this principle. The reviewers noted that BNFL had redefined "unacceptable release of radioactivity" to "a release of radiological or chemical material that would exceed the worker or public exposure standards of Safety Criteria 2.0-1 and/or 2.0-2." Also, BNFL's safety criterion extended "beyond the operational phase" to "the decontamination and decommissioning (D&D) phase of TWRS-P," because the Criterion omits the limitation expressed in the top-level principle by the condition "during the operational life of the facility." The reviewers determined that these changes did not alter the intent of the standard. However, the BNFL did not provide subordinate (implementing) standards for this principle.

Criticality, Top-Level Principle 4.2.2.5

BNFL SRD, Vol. II Safety Criterion 4.2-3 states, “The facility shall be designed and operated in a manner that prevents nuclear criticality.

The reviewers determined that SC 3.3-1 incorporates and conforms to this principle as it is a restatement of the principle substituting the word “should” in the top-level principle with “shall.” With respect to subordinate standards, Safety Criteria 3.3-2 through 3.3-8 adequately describe implementing ad hoc standards.

Conclusions

The reviewers concluded that BNFL did not adequately incorporate and conform to all of the Top-Level Principles for “Proven Engineering Practices and Margins.” Top-Level Principles 4.2.2.2, “Common-Mode/Common-Cause,” and 4.2.2.3, “Safety System Design and Qualification,” does not conform because all aspects of the principles were not addressed. For Top-Level Principle 4.2.2.2, Safety Criteria 4.1-3, 4.1-4 and 4.3-3 only address the effect of natural phenomenon and hazards and not all categories of potential hazards, and only Design Class I and Design Class II SSCs and not all SSCs important to safety. With respect to Top-Level Principle 4.2.2.3, Safety Criterion 4.4-2 only addresses Design Class I mechanical and electrical equipment instead of all SSCs important to safety. Also, BNFL must modify the SRD to include adequate subordinate standards for Top-Level Principle 4.2.2.4, “Codes and Standards.”

3.2.3.2.3 Radiation Protection

Requirements

DOE/RL-96-0003 requires that approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the RO that (1) the set documented in the SRD includes all requirements of applicable laws and regulations; (2) the set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006; and (3) the set documented in the SRD will provide adequate safety if properly implemented.

Review Methodology

The reviewers evaluated the adequacy of the BNFL SRD to provide a set of radiological, nuclear, and process safety standards that conforms to the top-level standards and principles contained in DOE/RL-96-0006, Section 4.2.3, “Radiation Protection.” Section 4.2.3 contains four radiation protection principles that are applicable during design, construction, and pre-operational testing of the facility. These are as follows:

- Radiation Protection Practices (Top-Level Principle 4.2.3.1): “An acceptable system of radiation protection practices should be followed in the design, construction, and pre-operational testing phases of the facility for the protection of workers and the public.”

- Radiation Protection Features (Top-Level Principle 4.2.3.2): “In the design stage, radiation protection features should be incorporated to protect workers from radiation exposure and to keep emissions of radioactive effluents ALARA and within prescribed limits."

- Deactivation, Decontamination, and Decommissioning Design (Top-Level Principle 4.2.3.3): "The design of the facility should incorporate provisions to facilitate deactivation and the final decommissioning. The objective of these provisions should be to reduce radiation exposures to Hanford Site personnel and the public both during and following deactivation and decommissioning activities, and to minimize the quantity of radioactive waste generated during deactivation, decontamination, and decommissioning."

- Deactivation Plan (Top-Level Principle 4.2.3.4): "There should be an approved plan for deactivation of the facility before it is constructed."

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of radiation protection contained in DOE/RL-96-0006 and the requirements of 10 CFR 835. The information provided by BNFL was assessed to the following attributes: (1) the SRD contains all requirements of 10 CFR 835, and (2) other standards in the recommended set do not conflict with the requirements of 10 CFR 835. The evaluation was conducted through a review of the material presented in the BNFL SRD, dated September 26, 1997, and the resolution of questions developed in the review process.

Evaluation

The BNFL SRD, Vol. II, contains the Contractor's proposed set of standards. The following paragraphs describe the relationship of the four radiation protection principles (top-level standards) to the safety criteria proposed by BNFL (SC 1.0-10, SC 5.0-1, SC 5.3-3 through SC 5.3-7, SC 5.3-1, SC 5.3-2, SC 8.0-1, and SC 8.0-2).

Radiation Protection Practices, Top-Level Principle 4.2.3.1

A comprehensive review of the set of radiological, nuclear, and process safety standards documented in the BNFL SRD, Vol. II, (and subsequent revisions to Chapter 5) was performed against the requirements specified in 10 CFR 835. The BNFL SRD, Vol. I, Attachment E, "Compliance with Applicable Laws and Contract Requirements," was used to assist in the review. This review and a resulting concern are documented in RU Question 1.

Question 1 addresses the discrepancies that were identified relating to the standards set missing or not adequately addressing numerous 10 CFR 835 requirements; changing the scope or intent of numerous 10 CFR 835 requirements; contradicting (thereby ensuring noncompliance) several 10 CFR 835 requirements; and changing key words or phrases that could change the intent of several 10 CFR 835 requirements. Revisions to the BNFL SRD, Vol. II, Chapter 5, subsequently resolved the reviewers' concerns raised in Question 1.

The contractor's commitment to comply with 10 CFR 835 is included in the set of selected standards with the addition of a new safety criterion, SC 1.0-10. This safety criterion states: "In addition to the Safety Criteria contained herein, compliance with all requirements of 10 CFR 830.120 and 10 CFR 835 shall be achieved absent the granting of an exemption request to any specific requirement therein." SC 5.0-1 states that the BNFL Radiation Protection Program (RPP) shall be developed and submitted in compliance with 10 CFR 835 and that the content of the RPP shall address all items in 10 CFR 835. The reviewers consider the term "items" to mean explicit nuclear safety requirements in this context. The reviewers concluded that the BNFL SRD committed to compliance with 10 CFR 835.

Radiation Protection Features, Top-Level Principle 4.2.3.2

The contractor's design-related radiation protection standards are discussed in the BNFL SRD, Vol. II, Section 5.2, and include commitments to 10 CFR 835.1001 and 1002, which specify design ALARA requirements. The environmental radiological protection safety criteria are provided in the BNFL SRD, Vol. II, Section 5.3, and address areas related to radiological effluents (SCs 5.3-3 through 5.3-7) and a commitment to provide an Environmental Radiological Protection Program (ERPP) covering areas comparable to the ERPP requirements in Draft 10 CFR 834 (SC 5.3-1 and SC 5.3-2).

The reviewers performed a line-by-line review of BNFL's safety criteria in the BNFL SRD, Vol. II, Section 5, and compared it with the generally accepted environmental standards collated in Draft 10 CFR 834. As a result of this review, the reviewers generated Question 2, which involved a lack of depth and scope in the BNFL SRD with respect to environmental radiation protection. The Contractor subsequently provided revisions to the BNFL SRD, Vol. II, Section 5, which resolved the reviewers' concerns raised in Question 2.

The revised environmental radiological protection standards were deemed by the reviewers to be generally comparable to those found in Draft 10 CFR 834. If properly implemented, the Contractor's environmental radiological protection standards will provide adequate safety and ensure compliance with the Washington Administrative Code (WAC) environmental radiological protection requirements.

Deactivation, Decontamination, and Decommissioning Design, Top-Level Principle 4.2.3.3

The Contractor addressed the deactivation-related top-level principles in Section 8 (SC 8.0-1 and SC 8.0-2) of its SRD submittal. SC 8.0-1 states that there shall be an approved plan for deactivation of the facility before it is constructed, and that the objectives of the plan shall be to reduce radiation exposure to Hanford Site personnel and the public. The plan will also minimize the quantity of radioactive waste generated during deactivation, decontamination, and decommissioning. Features and procedures that simplify and facilitate decommissioning will be identified during the planning and design phase.

SC 8.0-2 addresses the design considerations during decontamination, and decommissioning. It states that the facilities shall be designed to simplify decontamination and decommissioning, reduce exposure to Site personnel and the public during these activities, and increase the potential for reuse. Features and procedures that simplify and facilitate decontamination and decommissioning, and that minimize equipment contamination and the generation of radioactive waste during deactivation, decontamination, and decommissioning will be identified during the planning and design phase.

The two deactivation-related safety criteria address all the key items identified in the top-level principles in DOE/RL-96-0006, Section 4.2.3.3, "Deactivation, Decontamination, and

Decommissioning Design," and in Section 4.2.3.4, "Deactivation Plan." As such, the Contractor's standards conform to these top-level principles.

Conclusions

The reviewers concluded that the Contractor's standards set conforms to the radiation protection principles contained in DOE/RL-96-0006, Section 4.2.3, "Radiation Protection." Additionally, the set of safety standards included in the BNFL SRD contains all requirements of 10 CFR 835 and conforms to the top-level standards and principles stipulated in DOE/RL-96-0006, Section 4.2.3. The reviewers concluded that the set of subordinate standards, in the form of safety criteria, which were adopted for inclusion in the SRD, would provide adequate safety if properly implemented.

3.2.3.2.4 Emergency Preparedness

Requirements

The DOE/RL-96-0003, Section 3.3.1, "Standards Approval," requires that the approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the RO that: (1) the set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, Rev. 0; and (2) the set documented in the SRD will provide adequate safety if properly implemented.

Review Methodology

DOE/RL-96-0006, Section 4.2.4, contains the following top-level principle relating to emergency preparedness:

- Support Facilities (Top-Level Principle 4.2.4.1): "The facility design should provide additional capability to place and maintain the facility in a safe state following an accident if the normal control areas are expected to become uninhabitable."

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principle of emergency preparedness contained in DOE/RL-96-0006. The evaluation was conducted through a review of the material presented in the BNFL SRD and the resolution of questions developed in the review process.

Evaluation

The BNFL SRD, Vol. II contains the Contractor's proposed set of standards. Detailed descriptions of the safety criterion proposed by BNFL (SC 4.3-7) are provided in the following paragraphs.

Support Facilities, Top-Level Principle 4.2.4.1

SC 4.3-7 addresses control room habitability design considerations. The safety criterion states that the control room or control area shall be designed to permit occupancy and actions to be taken to monitor the facility safely during normal operations, and to provide safe control of the facility for anticipated operational occurrences and accident conditions. If credit is taken for operator action to satisfy the public exposure standards of SC 2.0-1 and/or 2.0-2, then adequate radiation protection will be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body gamma and 30 rem beta skin for the duration of the accident. For occurrences and accidents involving chemical release, provisions shall be made such that the operator exposure does not exceed the worker exposure standards of SC 2.0-2.

SC 4.3-7 further states that consideration will also be given to accidents at nearby facilities if operator action is required to safely control the processes and bring them to a safe state. The need for an alternate system that would allow the processes to be placed in a safe state in the event that the primary control area is uninhabitable will be evaluated.

The control habitability safety criterion (SC 4.3-7) addresses all the key items identified in the top-level principle in DOE/RL-96-0006, Section 4.2.4.1, "Support Facilities." As such, the Contractor's standards conform to this top-level principle.

Conclusions

The reviewers concluded that SC 4.3-7 adequately incorporates and conforms to the emergency preparedness principle contained in DOE/RL-96-0006. The reviewers also concluded that this safety criterion includes sufficient implementing details to be a subordinate standard.

3.2.3.2.5 Inherent/Passive Safety Characteristics

Requirements

DOE/RL-96-0003 states that the approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the RO that: "…(2) The set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in the DOE-provided document titled *Top-level Radiological, Nuclear, and Process Standards and Principles for TWRS Privatization Contractors*, DOE/RL-96-0006, Rev 0. Section 4.2.5.1 contains the following top-level principle relating to inherent/passive safety characteristics:

- Safety Margin Enhancement (Top-Level Principle 4.2.5.1): "Design features that enhance the margins of safety through simplified, inherent, passive, or other highly reliable means to accomplish safety functions should be employed to the maximum extent practical."

Review Methodology

The reviewers evaluated the adequacy of the BNFL SRD to provide a set of radiological, nuclear, and process safety standards that conforms to the top-level standards and principles of inherent/passive safety characteristics contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: (1) the principles listed in DOE/RL-96-0006, Section 4.2, "Design, Construction, and Pre-Operational Testing" are tied directly to the design of the Contractor's facility; and (2) these principles are part of the Contractor's design process, and the selected standards used in the design are compatible with utilization of the stated principles. This examination was conducted through review of the material presented in the BNFL SRD, Vol. II, and the HAR, and the resolution of questions developed during the review.

Evaluation

BNFL SRD, Rev. 0, Vol. II, contains the Contractor's proposed set of standards. A detailed description of SC 4.1-2 is provided in the following paragraphs.

Safety Margin Enhancement, Top-Level Principle 4.2.5.1

SC 4.1-2, the proposed standard for general design, includes a requirement that states, “Items and processes shall be designed using sound engineering/scientific principles and appropriate standards. Design features that use simplified, inherently safe, passive, or other highly reliable means to accomplish the specified safety function should be employed to the maximum extent practical.”

The reviewers determined that SC 4.1-2 adequately incorporates and conforms to this principle except that the safety criterion does not explicitly state that the purpose of the criterion is to enhance the margins of safety. This difference adds additional conservatism to this principle in that all design features, instead of just those used to enhance margins of safety, will be based on this principle. However, BNFL does not provide an adequate subordinate standard for this principle because the codes and standards proposed by BNFL (ACI 318-95, ACI 318R-95, ACI 349-90, ACI 349R-90, AISC MO16-89, AISC N690-95, ASCE 4-86, ASCE 7-95, DOE-STD-1020-94 [Change 1, 1996], DOE-STD-1021-93 [Change 1, 1996], and UBC-94) do not adequately address the implementation of this principle.

Conclusions

The reviewers concluded that SC 4.1-2 adequately incorporates and conforms to the Top-Level Principle of “Inherent Passive Safety Characteristic.” BNFL did not provide an adequate subordinate standard for this principle.

3.2.3.2.6 Human Factors

Requirements

DOE/RL-96-0006, Section 4.2.6, contains the following three top-level principles relating to human factors:

- Human Error (Top-Level Principle 4.2.6.1): “The possibility of human error in facility operations should be taken into account in the design by facilitating correct decisions by operators and inhibiting wrong decisions, and by providing means for detecting and correcting or compensating for error.”

- Instrumentation and Control Design (Top-Level Principle 4.2.6.2): “Sufficient instrumentation and control capability should be provided so that under normal operating and postulated accident conditions, the operators can diagnose facility conditions, place and maintain the facility in a safe state, and mitigate accidents. If necessary, measures should be provided to protect the operator in the performance of these functions.”

- Safety Status (Top-Level Principle 4.2.6.3): “Parameters to be monitored in the control room should be selected and their displays arranged to ensure that operators have clear and unambiguous indications of the status of facility conditions important to safety, especially for identifying and diagnosing the actuation and operation of a system or component important to safety."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of human factors contained in DOE/RL-96-0006. The SRD was assessed to the following attributes: (1) the principles listed in DOE/RL-96-0006, Section 4.2, " Design, Construction, and Pre-Operational Testing" are tied directly to the design of the Contractor's facility; and (2) these principles are part of the Contractor's design process, and the selected standards used in the design are compatible with utilization of the stated principles. This examination was conducted through review of the material presented in the BNFL SRD, Vol. II, and the HAR, and the resolution of questions developed during the review.

Evaluation

The BNFL SRD, Vol. II contains the Contractor's proposed set of standards. Detailed descriptions of the safety criteria proposed by BNFL (SC 4.3-4 and SC 4.3-6) are provided in the following paragraphs.

Human Error, Top-Level Principle 4.2.6.1

BNFL SRD Vol. II Safety Criterion 4.3-6 states, in part, "The possibility of human error in facility operations shall be taken into account in the design by facilitating correct decisions by operators and inhibiting wrong decisions and by providing means for detecting and correcting or compensating for error. …The parameters and displays shall facilitate monitoring and the initiation and operation of systems designated as Design Class I or Design Class II."

The reviewers determined that SC 4.3-6 is, with one exception, essentially a restatement of the principle. The exception is Safety Criterion 4.3-6 references only Design Class I and II equipment and not, as a minimum, all equipment important to safety. Because of this exception, the reviewers determined that this safety criterion does not adequately incorporate or conform to this principle. The subordinate standard that BNFL proposed for this principle, IEEE 1023-88, "*Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations*," is an adequate implementing standard because it fully addresses human factors' applications.

Instrumentation and Control Design, Top-Level Principle 4.2.6.2

BNFL SRD Vol. II Safety Criterion 4.3-4 states, "Design Class I and II instrumentation and controls shall be provided to monitor variables and systems and control systems and components over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate public and worker safety by compliance to the standards of Safety Criteria 2.0-1 and 2.0-2, including those variables and systems that can affect the performance of Design Class I and II facility conditions. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges. The instrumentation and controls provided shall provide the ability to detect off normal conditions, mitigate accidents, and place the facility in a safe state."

The reviewers determined that a selected portion of SC 4.3-4 is, with one exception, essentially a restatement of the principle. The exception is Safety Criterion 4.3-4 references only Design Class I and II equipment and not, as a minimum, all equipment important to safety. Because of this exception, the reviewers determined that this safety criterion does not adequately incorporate or conform to this principle. The subordinate standard that BNFL proposed for this principle, IEEE 603-91, "*Criteria for the Safety Systems for Nuclear Power Generating Stations*," is an adequate implementing standard.

Safety Status, Top-Level Principle 4.2.6.3

BNFL SRD Vol. II Safety Criterion 4.3-6 states, in part, "The parameters to be monitored in control areas shall be selected and their displays arranged to ensure operators have clear and unambiguous indication of the status of the facility. The parameters and displays shall facilitate monitoring and the initiation and operation of systems designated as Design Class I or Design Class II."

The reviewers determined that SC 4.3-6 is, with one exception, essentially a restatement of the principle. The exception is Safety Criterion 4.3-6 references only Design Class I and II equipment and not, as a minimum, all equipment important to safety. Because of this exception, the reviewers determined that this safety criterion does not adequately incorporate or conform to this principle. The subordinate standard that BNFL proposed for this principle, IEEE 1023-88, "Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations," is an adequate implementing standard.

Conclusions

The reviewers concluded that Safety Criterion 4.3-4 and Safety Criterion 4.3-6 do not adequately incorporate or conform to the Top-Level Principles of Human Factors because these criteria address only Design Class I and II equipment and not, as a minimum, all equipment important to safety. The subordinate standards that BNFL proposed as implementing standards for these principles are adequate.

3.2.3.2.7 Reliability, Availability, Maintainability, Inspectability (RAMI)

Requirements

DOE/RL-96-0003 requires that BNFL conform to the top-level standards into its recommended set of standards and safety requirements. DOE/RL-96-0006, Section 4.2.7, contains the following two top-level principles relating to reliability, availability, maintainability, and inspectability:

- Reliability (Top-Level Principle 4.2.7.1): "Reliability targets should be assigned to structures, systems, and components or functions important to safety. The targets should be consistent with the roles of the structures, systems, and components or functions in different accident conditions. Provisions should be made for appropriate testing and inspection of structures, system, and components for which reliability targets have been set."

- Availability, Maintainability, and Inspectability (Top-Level Principle 4.2.7.2): "Structures, systems, and components important to safety should be designated, designed, and constructed for appropriate inspection, testing, and maintenance throughout their operating lives to verify their continued acceptability for service with an adequate safety margin."

In accordance with the DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the set of standards documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006.

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of reliability, availability, maintainability, and inspectability contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: verify that (1) the selected standards allow implementation of the top-level standards, (2) the principles are part of the Contractor's design process, and (3) all selected standards used in the design are compatible with utilization of the stated principles. This examination was conducted through a review of the material presented in the BNFL SRD.

Evaluation

The BNFL SRD, Vol. II contains the Contractor's proposed set of standards. Detailed descriptions of the safety criteria proposed by BNFL (SC 4.4-2 and SC 4.4-3) are provided in the following paragraphs.

Reliability, Top-Level Principle 4.2.7.1

BNFL SRD Vol. II provided no safety criteria for this principle. In response to Question 189, BNFL acknowledged that this principle was inadvertently omitted and would be added in the next revision to the SRD.

The reviewers determined that BNFL did not adequately incorporate or conform to this principle because a safety criteria for this principle was not provided. Also, no subordinate standard for this principle was provided.

Availability, Maintainability, and Inspectability, Top-Level Principle 4.2.7.2

BNFL SRD Vol. II Safety Criterion 4.4-3, states: "Systems and components designated as Design Class I or Design Class II shall be designed and constructed to permit inspection, testing, and maintenance throughout their operating lives to verify their continued acceptability for service with an adequate safety margin." The safety criteria specifies two implementing codes and standards: (1) IEEE 338-87, *Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems*; and (2) IEEE 603-91, *Criteria for Safety Systems for Nuclear Power Generating Stations*.

The reviewers determined that SC 4.4-3 is, with one exception, essentially a restatement of the principle. The exception is Safety Criterion 4.4-3 references only Design Class I and II systems and components and not, as a minimum, all SSCs important to safety. Because of this exception, the reviewers determined that this safety criterion does not adequately incorporate or conform to this principle. In addition, based on the implementing codes and standards proposed for the above

Safety Criteria, the reviewers concluded that BNFL intends to apply the RAMI top level principle only to electrical components. The intent of the Contract is to apply the RAMI top level principle to all components important to safety. Therefore, the set of subordinate standards proposed for this principle are not adequate.

Conclusions

The reviewers concluded that the Contractor's proposed standard set for RAMI does not conform to the RAMI principle of DOE/RL-96-0006. The Contractor did not provide a safety criterion or subordinate standards for the Top-Level Principle of “Reliability,” and that Safety Criterion 4.4-3 applied to Design Class I and II SSCs, instead of important to safety SSCs and has not established adequate subordinate standards.

3.2.3.2.8 Pre-Operational Testing

Requirements

Pursuant to the DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles. DOE/RL-96-0006, Section 4.2.8, "Pre-Operational Testing," contains the following four top-level principles relating to pre-operational testing:

- Testing Program (Top-Level Principle 4.2.8.1): “A pre-operational testing program should be established and followed to demonstrate that the entire facility, especially items important to safety, has been constructed and functions according to the design intent, and to ensure that weaknesses are corrected.”

- Operational System and Functional Testing Procedures Validation (Top-Level Principle 4.2.8.2): “Procedures for normal facility and systems operations and for functional tests to be performed during the operating phase should be validated as part of the pre-operational testing program.”

- Safety System Data (Top-Level Principle 4.2.8.3): “During pre-operational testing, detailed diagnostic data should be collected on systems and components important to safety, and the initial operating parameters of the systems and components should be recorded.”

- Design Operating Characteristics (Top-Level Principle 4.2.8.4): “During pre-operational testing, the as-built operating characteristics of process systems, and systems and components important to safety should be determined and documented. Operating points should be adjusted to conform to values in the design basis. Training procedures and limiting conditions for operations should be modified to accurately reflect the operating characteristics of the system and components as built.”

Review Methodology

The reviewers evaluated the adequacy of the Contractor’s conformance to the top-level radiological, nuclear, and process safety standards and principles of pre-operational testing contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following criteria: verify that (1) the selected standards allow implementation of the top-level standard; (2) the principles are part of the Contractor's design process; and (3) all selected standards used in the design are compatible with utilization of the stated principles. This examination was conducted through a review of the material presented in the BNFL SRD.

Evaluation

The BNFL SRD, Vol. II contains the Contractor's proposed set of standards. Detailed descriptions of the safety criteria proposed by BNFL (SC 6.0-1, SC 6.0-2, SC 6.0-3, and SC 6.0-4) are provided in the following paragraphs.

Testing Program, Top-Level Principle 4.2.8.1

Safety Criterion 6.0-1 in BNFL SRD, Vol. II, Section 6.0, "Startup," states: "A pre-operational testing program shall be established and followed to demonstrate that Design Class I and Design Class II structures, systems and components have been properly constructed and can perform their specified safety function. The program shall provide for the detection, tracking and correction of deficiencies."

The reviewers found that this criterion does not adequately address an important aspect of this principle. The safety criterion differs from the top-level principle in that the safety criterion addresses Design Class I and II SSCs instead of those SSCs important to safety. Therefore, the reviewers determined that SC 6.0-1 does not adequately incorporate or conform to this principle. In addition, the safety criterion does not specify implementing codes or standards. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, by reference, BNFL must incorporate the applicable sections of the ISMP into the SRD.

Operational System and Functional Testing Procedures Validation, Top-Level Principle 4.2.8.2

Safety Criterion 6.0-2 in BNFL SRD, Vol. II, Section 6.0, "Startup," states: "Procedures for normal facility and system operation and for functional tests to be performed during the operating phase shall be validated as part of the pre-operational testing program."

The reviewers determined that this safety criterion adequately incorporates this principle because it exactly restates principle. However, the criterion does not identify subordinate standards (implementing codes or standards). In correspondence following the SRD submittal (BNFL Letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, by reference, BNFL must incorporate the applicable sections of the ISMP into the SRD.

Safety System Data, Top-Level Principle 4.2.8.3

Safety Criterion 6.0-3 in BNFL SRD, Vol. II, Section 6.0, "Startup," states: "During pre-operational testing, detailed diagnostic data should be collected on systems and components designated as Design Class I and Design Class II, and the initial operating parameters of the systems and components should be recorded."

The reviewers found that this criterion also does not adequately address an important aspect of this principle. The safety criterion differs from the top-level principle in that the safety criterion addresses Design Class I and II SSCs instead of those SSCs important to safety. Therefore, the reviewers determined that SC 6.0-3 does not adequately incorporate or conform to this principle. In addition, the safety criterion does not specify implementing codes or standards. In correspondence following the SRD submittal (BNFL Letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, by reference, BNFL must incorporate the applicable sections of the ISMP into the SRD.

Design Operating Characteristics, Top-Level Principle 4.2.8.4

Safety Criterion 6.0-4 in BNFL SRD, Volume II, Section 6.0, "Startup," states "During the pre-operational testing program, the as-built operating characteristics of process systems and systems and components designated as Design Class I and Design Class II shall be determined and documented. Operating points should be adjusted to conform to values in the design basis. Training procedures and limiting conditions for operation should be modified, if necessary, to accurately reflect the operating characteristics of the systems and components as built."

The reviewers found that this criterion also does not adequately address an important aspect of this principle. The safety criterion differs from the top-level principle in that the safety criterion addresses Design Class I and II SSCs instead of those SSCs important to safety. Therefore, the reviewers determined that SC 6.0-4 does not adequately incorporate or conform to this principle. In addition, the safety criterion does not specify implementing codes or standards. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, by reference, BNFL must incorporate the applicable sections of the ISMP into the SRD.

<u>Conclusions</u>

Of the four "Pre-Operational Testing" Top-Level Principles, BNFL does not adequately conform to three. BNFL does not adequately conform to Top-Level Principles 4.2.8.1, 4.2.8.3 and 4.2.8.4 because these principles address only Design Class I and II SSCs and not all SSCs important to safety. BNFL provided adequate ad hoc subordinate standards for the four principles in the ISMP; however, these standards must be incorporated in the SRD by reference.

3.2.3.3 Operations

3.2.3.3.1 Conduct of Operations

<u>Requirements</u>

DOE/RL-96-0003 requires that the Contractor conform to the top-level safety standards and principles of DOE/RL-96-0006. The Contractor must first address these top-level standards and principles in their standards and requirements and then the Contractor shall incorporate the top-level radiological, nuclear, and process standards and principles into the recommended standards and requirements. Furthermore, DOE/RL-96-0005 requires that the Contractor identify a set of subordinate standards that when properly implemented provide adequate safety, comply with legal requirements and conform to the top-level standards and principles. DOE/RL-96-0006, Section 4.3.1, "Conduct of Operations," includes the following eight top-level principles:

- Organizational Structure (Top-Level Principle 4.3.1.1): "The Contractor should exert full responsibility for the safe operation of the facility through a strong, unambiguous organizational structure."

- Normal Operations (Top-Level Principle 4.3.1.2): "Operations should be conducted in accordance with approved operational safety requirements and in strict accordance with administrative and procedure controls."

- Emergency Operating Procedures (Top-Level Principle 4.3.1.3): "To provide a basis for suitable operator response to accident conditions, emergency operating procedures should be established, documented, and approved."

- Readiness (Top-Level Principle 4.3.1.4): "The facility manager should ensure that all elements for safe facility operation are in place including an adequate number of qualified and experienced workers. Minimum requirements also should be set for the availability of staff and equipment."

- Internal Surveillance and Audits (Top-Level Principle 4.3.1.5): "Internal safety review procedures should be used by the Contractor to provide a continuing surveillance and audit of facility operational safety and to support the facility manager overall safety responsibility."

- Operations Within the Authorization Basis (Top-Level Principle 4.3.1.6): "Operations should be conducted in accordance with approved TSRs. Limiting conditions of operation, limiting control settings, and safety limits should be established as necessary to ensure operation within the authorization basis."

- Access to Technical Safety Support (Top-Level Principle 4.3.1.7): "Throughout the life of the facility, the Contractor should have access to engineering and technical support personnel, who are competent in all disciplines important to safety."

- Operational Events (Top-Level Principle 4.3.1.8): "Facility management should institute measures to ensure that events relevant to safety are detected and evaluated, and that necessary corrective measures are taken promptly and information on them is disseminated. Operational event reports should be prepared and submitted to the Director of the Regulatory Unit. The facility management should have access to operational safety experience."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process Safety Standards and Principles of conduct of operations contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following criteria: (1) verify that the selected standards allow implementation of the top-level standard; (2) the principles are part of the Contractor's design process, and (3) all selected standards used in the design are compatible with utilization of the stated principles. This examination was conducted through a review of the material presented in the BNFL SRD.

Evaluation

The BNFL SRD, Vol. II, Rev. 0, contains the Contractor's proposed set of standards as safety criteria. Detailed descriptions of the safety criteria (SC) proposed by BNFL (SC 7.3-2, SC 7.6-4, SC 7.7-2, SC 7.0-1, SC 7.0-4, SC 7.5-2, SC 7.2-6, SC 7.2-2, SC 7.2-4, SC 7.6-2, SC 7.1-3, SC 9.2-1, SC 9.2-3, SC 7.2-1, SC 7.7-6, SC 7.7-3, SC 7.7-4, SC 7.7-5, and SC 7.7-7) are provided in the following paragraphs.

Organizational Structure, Top-Level Principle 4.3.1.1

The BNFL SRD, Vol. II, Section 7.0, "Management and Operations," Safety Criterion 7.0-4 states, "The assignment and subdivision of responsibility for safety within the contractor's organization shall be kept well defined throughout the life of the facility."

The reviewers determine that Safety Criterion 7.0-4 does not adequately incorporate and conform to this principle. The principle requires that the Contractor "exert full responsibility" for safe operation of the facility. However, the safety criterion only discusses the assignment and subdivision of responsibility and does not state that BNFL will assume full safety responsibility. The issue of full safety responsibility is further questioned by the proposed formation of a "limited liability corporation."

Additionally, BNFL identified no subordinate (implementing) standards for this principle. In correspondence following the SRD submittal (BNFL Letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding the subordinate standard for organizational structure. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for organizational structure. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Normal Operations, Top-Level Principle 4.3.1.2

The BNFL SRD, Vol. II, Section 7.0, "Management and Operations," SC 7.0-1 states: "Normal operations shall be conducted in accordance with approved operational safety requirements and in strict accordance with administrative and procedure controls."

The reviewers determine that Safety Criterion 7.0-1 adequately incorporates and conforms to this principle. However, BNFL identified no subordinate (implementing) standards for this principle. In correspondence following the SRD submittal (BNFL Letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding the subordinate standard for organizational structure. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for normal operations. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Emergency Operating Procedures, Top-Level Principle 4.3.1.3

The BNFL SRD, Vol. II, Section 7.5, "Conduct of Operations," SC 7.5-2 states, in part: "The conduct of operations program shall address…(19) Emergency operating procedures for dealing with responses to accident conditions." This criterion references Top-Level Principle 4.3.1.3 as its regulatory basis. Additionally, SC 7.2-6 discusses procedures including procedures for emergency operations.

The reviewers determined that together these two safety criteria adequately incorporate and conform to the top-level standard. However, BNFL identified no subordinate (implementing) standards for this principle. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding the subordinate standard for emergency operating procedures. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for emergency operating procedures. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Readiness, Top-Level Principle 4.3.1.4

The reviewers determined that Safety Criterion 7.5-2 does not fully address the requirements of Top-Level Principle 4.3.1.4 even though it identifies Top-Level Principle 4.3.1.4 as its regulatory basis. SC 7.5-2 states: "The conduct of operations program shall address: (1) operations organization and administration and (5) Control of on-shift training." SC 7.2-2 and SC 7.2-4 incorporate some of the elements of this principle that are not addressed in SC 7.5-2, but do not address all the elements of this principle. Therefore, these safety criteria do not conform to this principle because operator experience and qualifications and minimum requirements for the availability of staff or equipment are not addressed. Additionally, BNFL identified no subordinate (implementing) standards for this principle. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard. In this correspondence BNFL stated that a section of the ISMP served as the subordinate standard for this principle. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Internal Surveillance and Audits, Top-Level Principle 4.3.1.5

Safety Criterion 7.1-3 identifies Top-Level Principle 4.3.1.5 as its regulatory basis; however, this criterion does not fully address the requirements of this principle. SC 7.1-3 states: "A framework shall be established for safety review organizations that are responsible for the safety of the facility" and "Internal safety oversight should be conducted by qualified personnel to ensure that the safety standards are consistently met." The internal safety review procedures described in the top-level principle were not addressed in other safety criteria. Therefore, SC 7.1-3 does not conform to this principle because it does not address the procedures that are mandated by the principle. Additionally, BNFL identified no subordinate (implementing) standards for this principle. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for Internal Surveillance and Audits. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Operations Within the Authorization Basis, Top-Level Principle 4.3.1.6

The BNFL SRD, Vol. II, Section 9.2, "Technical Safety Requirements," SC 9.2-1 states: "Technical safety requirements shall be prepared and submitted for approval, and the facility shall be operated in accordance with the approved technical safety limits." This criterion addresses the first part of the top-level standard. SC 9.2-3 adds further information regarding limiting conditions for operation, limiting control settings, and safety limits that adequately address the remaining points of the top-level standard. Collectively, these safety criteria adequately incorporated and conform to the top-level principle. However, BNFL identified no subordinate (implementing) standards for this principle. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding the subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for this principle. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Access to Technical Safety Support, Top-Level Principle 4.3.1.7

The BNFL SRD, Vol. II, Section 7.2, "Training and Procedures," SC 7.2-1 states: "Programs providing for continual training and qualification for operations, maintenance, and technical support personnel, to enable them to perform their duties safely and efficiently, shall be developed and implemented utilizing a tailored approach." This criterion appears to address this principle with two distinctions. First, the top-level principle clearly states "throughout the life of the facility." It can be inferred, based on the Contractor's level of effort, that trained personnel will be used throughout the life of the facility. Second, the top-level principle specifically mentions engineering personnel and the criterion does not. It can be interpreted that technical support personnel, as used in the criterion, include engineering personnel. In reference to the considerations listed above, the cited criterion adequately addresses the top-level principle. However, BNFL identified no subordinate (implementing) standards for this principle. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding the subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for this principle. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Operational Events, Top-Level Principle 4.3.1.8

The BNFL SRD, Vol. II, Section 7.7, "Reporting and Incident Investigation," addresses each point in the top-level principle using several of its associated criteria. SC 7.7-6 is specifically cited as using Top-Level Principle 4.3.1.8 as a regulatory basis; however, this criterion in itself does not address the entire principle. Other safety criteria that satisfy parts of the top-level principle include SC 7.7-3, SC 7.7-4, SC 7.7-5, and SC 7.7-7. Collectively, these safety criteria adequately incorporate and conform to this principle. However, BNFL identified no subordinate (implementing) standards for this principle. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding the subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Conclusions

Of the eight top-level principles associated with the "Conduct of Operations" the SRD adequately incorporates and conforms to five of the principles. BNFL Safety Criteria do not adequately conform to the Top-Level Principle for "Conduct of Operation" for the following reasons:

- Safety Criterion 7.0-4 does not adequately address or incorporate the "full safety responsibility" aspect of Top-Level Principle 4.3.1.1, "Organizational Structure."
- Safety Criteria 7.5-2, 7.2-2 and 7.2-4 do not adequately address or incorporate the operator experience and qualifications and minimum requirements for the availability of staff or equipment aspects of Top-Level Principle 4.3.1.4, "Readiness."
- Safety Criterion 7.1-3 does not adequately address or incorporate the procedure aspect of Top-Level Principle 4.3.1.5, "Internal Surveillance and Audits."

BNFL provided adequate ad hoc subordinate standards in the ISMP for the principles of conduct of operations; however, these standards must be incorporated by reference in the SRD.

3.2.3.3.2 Radiation Protection

Requirements

DOE/RL-96-0003, February 1996, Section 3.3.1, "Standards Approval," requires that approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements be issued upon determination by the RO that, (1) the set documented in the BNFL SRD includes all requirements of applicable laws and regulations; 2) the set documented in the BNFL SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006; and (3) the set documented in the SRD will provide adequate safety if properly implemented.

Review Methodology

DOE/RL-96-0006, Section 4.3.2, contains the following three top-level principles relating to radiation protection. The principles are defined as follows:

- Radiation Practices (Top-Level Principle 4.3.2.1): "An acceptable system of radiation protection practices should be followed in the operational phase for the protection of workers and the public."

- Procedures and Monitoring (Top-Level Principle 4.3.2.2): "The radiation protection personnel within the Contractor's operating organizations should establish written procedures for the control, guidance, and protection of personnel. Also, they should routinely monitor facility Site radiological conditions; the exposure of facility personnel to radiation; and releases of radioactive effluents."

- Final Deactivation Plans and Provisions (Top-Level Principle 4.3.2.3): "Deactivation of the facility should be planned. These plans and provisions should incorporate radiation protection practices to protect Hanford Site personnel and the public, both during and following deactivation activities, and waste minimization procedures to reduce the amount of radioactive waste generated during deactivation."

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of radiation protection contained in DOE/RL-96-0006 and all requirements of 10 CFR 835. The information provided by BNFL was assessed to the following attributes: (1) the SRD contained all requirements of 10 CFR 835, and (2) other standards in the recommended set did not conflict with the requirements of 10 CFR 835. The evaluation was conducted through a review of the material presented in the BNFL SRD and the resolution of questions developed in the review process.

Evaluation

The BNFL SRD, Vol. II, contains the Contractor's proposed set of standards. Detailed descriptions of the safety criteria proposed by BNFL (SC 1.0-10, SC 5.0-1, SC 5.3-1 through SC 5.3-7, SC 8.0-1, and SC 8.0-2) are provided in the following paragraphs.

Radiation Practices, Top-Level Principle 4.3.2.1

A comprehensive review of the set of radiological, nuclear, and process safety standards documented in the BNFL SRD, Vol. II, Rev. 0 (and subsequent committed to revisions of SRD, Vol. II, Section 5), was performed against the requirements specified in 10 CFR 835. BNFL SRD, Vol. I, Rev. 0, Attachment E, "Compliance with Applicable Laws and Contract Requirements," was used to assist in the review. This review and a resulting concern are documented in RU Question 1.

Question 1 addresses discrepancies that were identified in relation to the standards set missing or not adequately addressing numerous 10 CFR 835 requirements; changing the scope or intent of numerous 10 CFR 835 requirements; contradicting (thereby ensuring noncompliance) several 10 CFR 835 requirements; and changing key words or phrases that could change the intent of several 10 CFR 835 requirements. BNFL committed to revise the SRD Vol. II, Sections 1 and 5 to resolve the reviewers' concerns raised in Question 1.

In reference to BNFL SRD Vol. II, Section 1, BNFL committed to compliance with 10 CFR 835 by committing to add Safety Criterion 1.0-10. This committed to safety criterion would state: "In addition to the Safety Criteria contained herein, compliance with all requirements of

10 CFR 830.120 and 10 CFR 835 shall be achieved absent the granting of an exemption request to any specific requirement therein." The reviewers discussed this committed to change with BNFL and determined that the change, when implemented, would resolve one of the concerns raised in Question 1.

In reference to BNFL SRD Vol. II, Section 5, on December 8, 1997, BNFL provided a revision to the SRD that changed one safety criterion and added two safety criteria. BNFL revised Safety Criterion 5.0-1 to state, "A Radiation Protection Program (RPP) compliant with 10 CFR 835 shall be developed and submitted for approval to the RU in accordance with the schedule provided in the BNFL Contract. The content of the RPP shall address all items in 10 CFR 835 and the additional criteria provided in Sections 5.1 and 5.2." BNFL also added Safety Criteria 5.1-1 and 5.1-2 to address high radiation areas and a respiratory protection program, respectively. These changes adequately addressed one of the concerns raised in Question 1.

The reviewers determined that upon implementing their commitment to add Safety Criterion 1.0-10, BNFL will have adequately incorporated and conformed to this principle.

Procedures and Monitoring, Top-Level Principle 4.3.2.2

The Contractor's design-related radiation protection standards were found in the BNFL SRD, Vol. II, Section 5.2, and included commitments to 10 CFR 835.1001 and 1002, which specify design requirements to ensure that occupational exposures during operations will remain ALARA. The public and environmental radiological protection safety criteria were found in Section 5.3 of the BNFL SRD, Vol. II, and addressed areas related to radiological effluents (Safety Criteria 5.3-3 through 5.3-7) and a commitment to provide an ERPP addressing areas comparable to the ERPP requirements in Draft 10 CFR 834 (Safety Criteria 5.3-1 and 5.3-2).

The reviewers performed a line-by-line review of BNFL's safety criteria in the BNFL SRD, Vol. II, Section 5, and compared them with the generally accepted environmental standards collated in Draft 10 CFR 834. As a result of this review, the reviewers generated Question 2, which involved a lack of depth and scope in the BNFL SRD with respect to environmental radiation protection. On December 8, 1997, the Contractor provided revisions to the BNFL SRD, Vol. II, Section 5, which resolved the reviewers' concerns raised in Question 2.

The revised environmental radiological protection standards were deemed by the reviewers to be generally comparable to those found in Draft 10 CFR 834. If properly implemented, the Contractor's environmental radiological protection standards will provide adequate safety and ensure compliance with the WAC environmental radiological protection requirements.

Final Deactivation Plans and Provisions, Top-Level Principle 4.3.2.3

The Contractor addressed the deactivation-related top-level principles in Section 8 (SC 8.0-1 and SC 8.0-2) of its SRD submittal. SC 8.0-1 states that there shall be an approved plan for deactivation of the facility before it is constructed, and that the objectives of the plan shall be to reduce radiation exposure to Hanford Site personnel and the public. The plan will also minimize the quantity of radioactive waste generated during deactivation, decontamination, and decommissioning. Features and procedures that simplify and facilitate decommissioning will be identified during the planning and design phase.

SC 8.0-2 addresses the design considerations during Deactivation and Decommissioning (D&D). SC 8.0-1 states that the facilities shall be designed to: simplify D&D; reduce exposure to Site personnel and the public during these activities; and increase the potential for reuse. Features and procedures that simplify and facilitate D&D; minimization of contaminated equipment; and the generation of radioactive waste during deactivation, decontamination, and decommissioning will be identified during the planning and design phase.

The two deactivation-related safety criteria addressed all of the key items identified in the top-level principles in DOE/RL-96-0006, Section 4.3.2.3, “Final Deactivation Plans and Provisions.” As such, the Contractor's standards conform to these top-level principles.

Conclusions

The reviewers concluded that the Contractor’s standard set adequately incorporates and conforms to the radiation protection principles contained in DOE/RL-96-0006. Additionally, the set of safety standards included in the BNFL SRD contain all requirements of 10 CFR 835 and conforms to the top-level standards and principles stipulated in DOE/RL-96-0006, Section 4.3.2. “Radiation Protection.”

3.2.3.3.3 Emergency Preparedness

Requirements

DOE/RL-96-0003, Section 3.3.1, “Standards Approval,” requires that the approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements be issued upon determination by the RO that: the set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006 and the set documented in the SRD will provide adequate safety if properly implemented.

Review Methodology

DOE/RL-96-0006, Rev.0, Section 4.3.3, “Emergency Preparedness” identifies the following three Top-Level Principles that are applicable during operation of the facility. The principles are defined as follows:

- Offsite Measures (Top-Level Principle 4.3.3.1): “Hanford Site and offsite mitigation measures should be provided to substantially reduce the effects of an unacceptable accidental release of radioactive material.”

- Accident Management Strategy (Top-Level Principle 4.3.3.2): “The results of analyses of the response of the facility to accidents with the potential for releases resulting in doses in excess of EPA and Washington State emergency cleanup standards beyond the facility control perimeter (security fence), should be used in preparing guidance on an accident management strategy.”

- Establishment and Continued Exercise of Emergency Plans (Top-Level Principle 4.3.3.3): “Emergency plans should be prepared before the startup of the facility and exercised periodically to ensure that protection measures can be

> implemented in the event of an accident that results in, or has the potential for, unacceptable releases of radioactive materials within and beyond the facility control perimeter. Emergency planning zones defined around the facility should allow for the use of a graded response."

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of emergency preparedness contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: the selected standards in the SRD addressed all aspects of the top-level principles. The evaluation was conducted through a review of the material presented in the BNFL SRD, Rev. 0, dated September 26, 1997, and the resolution of questions developed in the review process.

Evaluation

The BNFL SRD, Vol. II contains the Contractor's proposed set of standards. The Contractor's SRD Safety Criterion SC 7.8-3 through SC 7.8-5 addresses the top-level principle of DOE/RL-96-0006, Section 4.3.3, "Emergency Preparedness." Detailed descriptions of these safety criteria proposed by BNFL are provided in the following paragraphs.

Offsite Measures, Top-Level Principle 4.3.3.1

BNFL SRD, Vol. II, Section 7.8, "Emergency Preparedness," Safety Criterion 7.8-5 states, "The emergency response plan shall be coordinated with the DOE Hanford Site and local community emergency response plans." The BNFL SRD identified no implementing codes and standards for this safety criterion.

The reviewers determined that SC 7.8-5 adequately incorporates and conforms to this principle because the objective of a coordinated emergency response plan is to reduce the effects of an unacceptable accidental release of radioactive material. Additionally, in correspondence subsequent to the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided information regarding the subordinate standards for this principle. In this correspondence BNFL stated that a section of the ISMP served as the subordinate standard. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Accident Management Strategy, Top-Level Principle 4.3.3.2

BNFL SRD, Vol. II, Section 7.8, "Emergency Preparedness," Safety Criterion 7.8-4 states, "The results of analyses of the facility response to accidents with the potential for releases resulting in doses that exceed EPA and Washington State emergency cleanup standards beyond the TWRS-P controlled area boundary shall be used in preparing emergency operating procedures, which will contain specific instructions for facility operations personnel on the shutdown of facility processes and the mitigation of accidents for all identified off-normal and emergency conditions." The BNFL SRD identified no implementing codes and standards for this safety criterion.

The reviewers determined that SC 7.8-4 incorporates and conforms to this principle because the safety criterion essentially restates the principle. Additionally, in correspondence subsequent to the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided information regarding the subordinate standards for this principle. In this correspondence BNFL stated that a section of the ISMP served as the subordinate standard. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable section of the ISMP into the SRD.

Establishment and Continued Exercise of Emergency Plans, Top-Level Principle 4.3.3.3

BNFL SRD, Vol. II, Section 7.8, "Emergency Preparedness," SC 7.8-3 states, "The emergency plans shall be prepared before the startup of the facility, and shall be exercised periodically to ensure that protection measures can be implemented in the event of an accident that results in, or has the potential for, unacceptable releases of radioactive materials within and beyond the facility control perimeter. A determination shall be made of the size of the geographic area surrounding the facility, known as the Emergency Planning Zone (EPZ), within which special planning and preparedness activities will be performed to reduce the potential health and safety impacts from an event involving hazardous materials. The extent of necessary planning and preparedness shall correspond to the type and scope of hazards and the potential consequences of events."

The reviewers determined that SC 7.8-3 incorporates and conforms to this principle because the safety criterion essentially restates the principle. Additionally, in correspondence subsequent to the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided information regarding the subordinate standards for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Conclusions

The reviewers concluded that the Contractor's standard set conforms to the three Top-Level Principles of "Emergency Preparedness." However, BNFL must incorporate into the SRD by reference the proposed subordinate standards described in the ISMP.

3.2.3.3.4 Training and Qualification

Requirements

DOE/RL-96-0003 requires that BNFL incorporate the top-level standards into its recommended set of standards and safety requirements. DOE/RL-96-0006, Section 4.3.4, "Training and Qualification" contains the following three top-level principles:

- Personnel Training (Top-Level Principle 4.3.4.1): "Personnel engaged in activities bearing on facility safety should be trained and qualified to perform their duties."

- Training Programs (Top-Level Principle 4.3.4.2): "Programs should be established for continual training of operations and maintenance personnel to enable them to perform their duties safely and efficiently."

- Conditions Beyond Design Basis (Top-Level Principle 4.3.4.3): "Operating staff should be trained and retrained in the procedures to follow if conditions exceed the design basis of the facility."

Review Methodology

The reviewers assessed the BNFL SRD, Vol. II, Rev. 0, to determine whether the Contractor's set of selected standards conformed to the Training and Qualification Principle of the top-level standards.

Evaluation

The BNFL SRD, Vol. II, Rev. 0 contains the Contractor's proposed set of standards for "Training and Qualifications." Detailed descriptions of the safety criteria proposed are provided in the following paragraphs.

Personnel Training, Top-Level Principle 4.3.4.1

BNFL SRD, Vol. II, Section 7.2, "Training and Procedures," SC 7.2-4 states, in part, "Each employee involved in operating a process shall be trained in an overview of the process and in the operating procedures/instructions. The training shall include emphasis on the specific safety and health hazards, operating limits, emergency operations including shutdown, and safe work practices applicable to the employee's job tasks."

The reviewers determined that SC 7.2-4 incorporates and conforms to this principle because the safety criterion adequately addresses all aspects of the principle. Additionally, the reviewers determined that Safety Criterion 7.2-2 was an adequate subordinate (implementing) standard for this principle.

Training Programs, Top-Level Principle 4.3.4.2

BNFL SRD, Vol. II, Section 7.2, "Training and Procedures," SC 7.2-1 states, "Programs providing for continual training and qualification for operations, maintenance, and technical support personnel, to enable them to perform their duties safely and efficiently shall be developed and implemented utilizing a tailored approach."

The reviewers determined that SC 7.2-1 incorporates and conforms to this principle because the safety criterion adequately addresses all aspects of the principle. Additionally, the reviewers determined that Safety Criterion 7.2-2 was an adequate subordinate (implementing) standard for this principle.

Conditions Beyond Design Basis, Top-Level Principle 4.3.4.3

BNFL SRD, Vol. II, Section 7.2, "Training and Procedures," Safety Criterion 7.2-4 states, in part, "Refresher training shall be provided at least every three years, and more often if necessary, to each employee involved in operating a process to assure that the employee understands and adheres to the current operating procedures/instructions of the process and is proficient in the procedures to follow if conditions exceed the design basis of the facility."

The reviewers determined that SC 7.2-4 incorporates and conforms to this principle because the safety criterion adequately addresses all aspects of the principle. Additionally, the reviewers determined that Safety Criterion 7.2-2 was an adequate subordinate (implementing) standard for this principle. Furthermore, in its supplemental response to Question 157, BNFL committed to cite the ISMP, Sections 1.3.12, "Training;" 3.15, "Training and Qualifications;" 4.2.2, "Training and

Procedures;" and 5.6.3, "Development of the Operator Training Program," as implementing codes and standards.

Conclusions

The reviewers concluded that the Contractor's standard set adequately incorporates and conforms to the three Top-Level Principles of "Training and Qualifications." BNFL also proposed adequate subordinate standards for this principle; however, the applicable sections of the ISMP must be incorporated into the SRD by reference.

3.2.3.3.5 Operational Testing, Inspection, and Maintenance

Requirements

In accordance with the DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006. DOE/RL-96-0006 requires that the Contractor's SRD address and incorporate the top-level standards into its recommended set of standards and safety requirements. DOE/RL-96-0006, Section 4.3.5 contains the following top-level principle.

Operational Testing, Inspection, and Maintenance (Top-Level Principle 4.3.5.1): "Structures, systems, and components important to safety should be the subject of appropriate, regular preventative maintenance, inspection, and testing and servicing when needed, to ensure that they remain capable of meeting their design requirements throughout the life of the facility. Such activities should be carried out in accordance with written procedures supported by quality assurance measures."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of operational testing, inspection, and maintenance contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: (1) verify that the selected standards allow implementation of the top-level principle; (2) the principles are part of the Contractor's design process, and (3) all selected standards used in the design are compatible with utilization of the stated principles. This examination was conducted through a review of the material presented in the BNFL SRD.

Evaluation

The BNFL SRD, Vol. II, Section 7.6, "Conduct of Maintenance," contains four safety criteria that address this principle. Detailed descriptions of the safety criteria proposed by BNFL (SC 7.6-1through SC 7.6-4) are provided in the following paragraph.

Operational Testing, Inspection and Maintenance, Top-Level Principle 4.3.5.1

BNFL SRD, Vol. II Safety Criterion 7.6-2 states, "The maintenance program shall contain provisions sufficient to preserve, predict, and restore the availability, operability, and reliability of structures, systems, and components designated as Design Class I and Design Class II."

Also, BNFL SRD, Vol. II Safety Criterion 7.6-3 states, "The maintenance program shall clearly define:

(1) The Design Class I and Design Class II structures, systems, and components that comprise the facility;

(2) The requirements of the maintenance program that are derived from the program elements listed in Safety Criterion 7.6-4.

(3) The management systems used for those activities, including the means for monitoring and measuring the effectiveness of the program and the management of maintenance backlog;

(4) The assignment of responsibilities and authority for all levels of the maintenance organization,

(5) Mechanisms to feedback such relevant information as trend analysis and instrumentation performance/reliability data in order to identify necessary program modifications,

(6) Provisions for identifying and evaluating possible component, system design, occupational safety and health, or other relevant problems and implementation of a self-assessment program;

(7) Performance indicators and criteria to be utilized to measure equipment, systems, and personnel effectiveness in maintenance activities;

(8) Interfaces between maintenance and other organizations (e.g., involving operations, engineering, quality, and safety); and

(9) Quantitative reliability target values for systems and components to start or run, when such values are credited in safety analysis."

In addition, BNFL SRD, Vol. II Safety Criterion 7.6-4 states, "The maintenance program shall address each of the following elements:

(1) Organization and administration;
(2) Maintenance training and qualification;
(3) Maintenance facilities, equipment, and tools;
(4) Types of maintenance;
(5) Maintenance procedures and other work-related documents;
(6) Planning, scheduling, and coordinating maintenance activities;
(7) Control of maintenance activities;
(8) Postmaintenance testing;
(9) Procurement of parts, materials, and services;
(10) Material receipt, inspection, handling, storage, retrieving, and issuance;
(11) Control and calibration of measuring and test equipment;
(12) Maintenance tools and equipment control;
(13) Documented facility condition inspections to identify and address aging effects;
(14) Management involvement with facility operations;

(15) Maintenance history and trending;
(16) Analysis of maintenance-related problems;
(17) Modification work."

The reviewers found that the BNFL SRD identified SC 7.6-3 and SC 7.6-4 as the standards proposed to incorporate and conform to this top-level principle. The reviewers determined that SC 7.6-2 also must be included to address the full intent of this top-level principle. However, the reviewers concluded that even with the addition of SC 7.6-2, these safety criteria do not adequately incorporate or conform to this principle because Design Class I and II SSCs are addressed and not all components "important to safety." The reviewers determined that selected elements of the four safety criteria were adequate as subordinate standards.

Conclusions

The reviewers concluded that BNFL Safety Criteria 7.6-2 through 7.6-4 do not adequately incorporate or conform to Top-Level Principle 4.3.5.1, "Operational Testing, Inspection and Maintenance," because the criteria do not address all components "important to safety." The reviewers determined that selected elements of the four safety criteria were adequate as subordinate standards.

3.2.3.3.6 Security

Requirements

Pursuant to DOE/RL-96-0003 and in order to approve the SRD, the RO must make a final determination that the set of standards documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in the DOE-provided document titled "Top-Level Radiological, Nuclear, and Process [Safety] Standards and Principles for TWRS Privatization Contractors, DOE/RL-96-0006, Revision 0."

DOE/RL-96-0006, Section 4.3.6, "Security," contains the following top-level principle:

- Security (Top-Level Principle 4.3.6.1): "Adequate provisions for facility security and physical protection of structures, systems, and components important to safety should be provided."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of security contained in DOE/RL-06-0006. The information provided by BNFL was assessed to the following attribute: "The reviewers should ensure that these principles [e.g., Security] are part of the Contractor's facility operational plans and that the selected standards which will be used to develop the operations of the facility are compatible with implementation of the stated principles."

Evaluation

The BNFL SRD, Vol. II, Rev. 0, contains the Contractor's proposed set of standards. A detailed description of the safety criteria proposed by BNFL (SC 4.1-6) is provided in the following paragraphs.

Security, Top-Level Principle 4.3.6.1

BNFL SRD Vol. II Safety Criterion 4.1-6 states "Adequate provisions for facility security and physical protection of structures, systems, and components shall be provided." The SRD proposed no implementing codes or standards.

The reviewers determined that SC 4.1-6 adequately incorporates and conforms to this principle because the criterion restated the principle. The BNFL SRD does not identify any implementing and subordinate standards for SC 4.1-6. However, Standard 5, "Safeguards and Security Program," of the TWRS Privatization Contract mandates that BNFL comply with "applicable regulations, DOE Orders, and DOE-provided top-level safeguards and security (S&S) requirements stipulated in *Top-Level Safeguards and Security Requirements for TWRS Privatization* (DOE/RL-96-0002)."

In particular, Attachment 1 to DOE Order 470.1, "Safeguards And Security Program," which will be applicable to the TWRS-P facility, requires that S&S programs "be designed to mitigate the consequences of radiological/toxicological sabotage that would cause unacceptable impact to national security or pose significant dangers to the health and safety of employees, the public, or the environment." The DOE Contract with BNFL also incorporates many of the standard DOE Acquisition Regulations (DEAR) clauses on S&S, including DEAR 952.204-2, DEAR 952.204-70, and DEAR 952.204-74. The BNFL S&S program will be overseen by DOE in the same manner as other DOE contractor facilities. Thus, the reviewers found that the applicable regulations, DOE Orders, and DOE/RL-96-0002, to which BNFL is bound by the Contract, serve in lieu of implementing/subordinate standards for SC 4.1-6. Furthermore, oversight of the S&S program by the RL and DOE-HQ provides an acceptable level of assurance that BNFL will establish and maintain an effective program for facility security and physical protection of SSCs.

Conclusion

The reviewers concluded that SC 4.1-6 adequately incorporates and conforms to Top-Level Principle 4.3.6.1, Security." Implementing standards are not required for this principle, because the Contract contains additional requirements that ensure adequate safety. The reviewers concluded that the Contractor's standards set conforms to the security principle contained in DOE/RL-96-0006.

3.2.3.4 Internal Safety Oversight

Requirements

DOE/RL-96-0003, Section 4.4, requires that the standards and requirements identified and recommended by the Contractor address the safety principle of internal safety oversight. Pursuant to DOE/RL-96-0006 and in order to approve the SRD, the RO must make a final determination that the set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, Revision 0 (including the top-level principle of internal safety oversight required by DOE/RL-96-0006, Section 4.4). Section 4.4, "Internal Safety Oversight," contains the following four top-level principles:

- Safety Review Organization (Top-Level Principle 4.4.1): "The Contractor should establish a framework for its safety review organizations that are responsible for assuring the safety of the facility. The separation between the responsibilities of the safety review organizations and those of the other organizations should remain clear so that the safety review organizations retain their independence as safety authorities."

- Qualified Personnel (Top-Level Principle 4.4.2): "Internal safety oversight should be conducted by qualified personnel to ensure that the safety standards are consistently met."

- Recommendations for Initiation of Construction (Top-Level Principle 4.4.3): "The Contractor should request authorization for construction only after being satisfied by appropriate internal assessments that the main safety issues have been satisfactorily resolved and that the remainder are amenable to solution before operations are scheduled to begin."

- Unresolved Safety Questions (Top-Level Principle 4.4.4): "All facility modifications after operations begin that can affect safety should be assessed by the Contractor for an "unreviewed safety question" and positive determinations submitted to the Director of the Regulatory Unit for review."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of internal safety oversight contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: (1) determine the compatibility of BNFL's standards with the internal safety oversight principle, and (2) ensure that the internal safety oversight principle is incorporated into the BNFL SRD. This examination was conducted through review of the material presented in the BNFL SRD.

Evaluation

The BNFL SRD, Vol. II contains the Contractor's proposed set of standards. Detailed descriptions of the safety criteria proposed by BNFL (SC 7.1-3 and SC 7.4-1) are provided in the following paragraphs.

Safety Review Organization, Top-Level Principle 4.4.1

BNFL SRD, Vol. II, Section 7.1, "Management Organization and Staffing," Safety Criterion 7.1-3 states, in part, "A framework shall be established for safety review organizations that are responsible for assuring the safety of the facility. The separation between the responsibilities of the safety review organizations and those of the other organizations shall remain clear so that the safety review organizations retain their independence as safety authorities." The BNFL SRD identified no subordinate standards for this safety criterion.

The reviewers determined that SC 7.1-3 adequately incorporates and conforms to this principle because the safety criterion essentially restates the principle. No subordinate standards were identified; however, in correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for Safety Review Organization. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Qualified Personnel, Top-Level Principle 4.4.2

BNFL SRD, Vol. II, Section 7.1, "Management Organization and Staffing," Safety Criterion 7.1-3 states, in part, "Internal safety oversight should be conducted by qualified personnel to ensure that the safety standards are consistently met." The BNFL SRD identified no subordinate standards for this safety criterion.

The reviewers determined that SC 7.1-3 adequately incorporates and conforms to this principle because the safety criterion essentially restates the principle. Adequate subordinate (implementing) standards were not proposed in the SRD.

Recommendations for Initiation of Construction, Top-Level Principle 4.4.3

The BNFL SRD, Vol. II did not provide a safety criterion or subordinate standard for this principle.

Unresolved Safety Questions, Top-Level Principle 4.4.4

BNFL SRD, Vol. II, Section 7.4, "Unreviewed Safety Questions," proposes five safety criteria for this principle. Safety Criterion 7.4-1 states, "A safety evaluation shall be performed to determine whether a situation involves a unreviewed safety question (USQ) for:

(1) Temporary or permanent changes in the facility as described in the existing safety analyses;

(2) Temporary or permanent changes in the procedures as derived from existing safety analyses; or

(3) Tests or experiments not described in existing safety analyses.

A situation involves a USQ if:

(1) The probability of occurrence or the consequences of an accident or malfunction of equipment previously evaluated in the facility safety analyses could be increased;

(2) The possibility of an accident or malfunction of a different type than any evaluated previously in the facility safety analyses could be created; or

(3) Any margin of safety, as defined in the bases for any technical safety requirement, is reduced."

The reviewers determined that SC 7.4-1 adequately incorporated and conforms to this principle. The reviewers also determined that together the five safety criteria of BNFL SRD Section 7.4, "Unreviewed Safety Question," are adequate subordinate standards for this principle.

Conclusions

The reviewers concluded that BNFL proposed safety criteria that incorporate and conform to three of the four "Internal Safety Oversight" Top-Level Principles. The BNFL SRD did not propose an adequate standard or subordinate standard for the "Recommendation for Initiation of Construction" Top-Level Principle. Also, adequate subordinate standards were not proposed for Top-Level Principle 4.4.2, "Qualified Personnel."

3.2.4 General Process Safety Principles

3.2.4.1 Overall Principles

Requirements

DOE/RL-96-0003 states that the approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the RO that: "…2) The set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in the DOE-provided document titled *Top-level Radiological, Nuclear, and Process Standards and Principles for TWRS Privatization Contractors*, DOE/RL-96-0006, Revision 0."

DOE/RL-06-0006, Section 5.1, "Overall Principles," contains the following three top-level principles relating to the overall principles of general process safety:

- Process Safety Management (Top-Level Principle 5.1.1): "The Contractor should use a comprehensive process safety management program to eliminate or reduce the incidence, or mitigate the consequences, of accidental hazardous chemical releases, process fires, and process explosions. This program should address management practices, technologies, and procedures."

- Process Safety Objective (Top-Level Principle 5.1.2): "Process safety management should confirm that the facility is properly designed, the integrity of the design is maintained, and the facility is operated according to the safe manner intended."

- Process Safety Responsibility (Top-Level Principle 5.1.3): "The ultimate responsibility for process safety rests with the Contractor. In no way should this responsibility be diluted by the separate activities and responsibilities of designers, suppliers, constructors, the RU, or independent oversight bodies."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and overall principles of process safety contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: (1) the Contractor's standards allow implementation of the safety principles listed in DOE/RL-96-0006, Section 5.1, "Overall Principles"; and (2) the Contractor's standards are compatible with the overall principles. This examination was conducted through review of the material presented in the BNFL SRD, Vol. II; the HAR; and the resolution of questions developed during the review.

Evaluation

The BNFL SRD, Vol. II contains the Contractor's proposed set of standards. Detailed descriptions of the safety criteria proposed by BNFL (SC 1.0-1, SC 7.0-1, SC 7.0-4, SC 7.1-3, and SC 7.1-4) are provided in the following paragraphs.

Process Safety Management, Top-Level Principle 5.1.1

BNFL SRD, Vol. II, Section 1.0, "Radiological, Nuclear and Process Safety Objectives," Safety Criterion 1.0-1 states, in part, "A comprehensive radiological and process safety management program shall be used to eliminate or reduce the incidence, or mitigate the consequences of, accidental radioactive or chemical releases, process fires, and process explosions. This program shall address management practices, technologies, and procedures." The BNFL SRD proposed no subordinate standards for this principle.

The reviewers determined that SC 1.0-1 incorporates and conforms to this principle because the safety criterion is essentially a restatement of the principle. No subordinate standards were identified; however, in correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for this principle. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Process Safety Objective, Top-Level Principle 5.1.2

BNFL SRD, Vol. II, Section 1.0, "Radiological, Nuclear and Process Safety Objectives," Safety Criterion 1.0-1 states, in part, "Radiological and process safety management shall confirm that the facility is properly designed, the integrity of the design is maintained, and the facility is operated according to the safe manner intended." The BNFL SRD proposed no subordinate standards for this principle.

The reviewers determined that SC 1.0-1 incorporates and conforms to this principle because the safety criterion is essentially a restatement of the principle. No subordinate standards were identified; however, in correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated that sections of the ISMP served as the subordinate standard for this principle. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Process Safety Responsibility, Top-Level Principle 5.1.3

BNFL SRD, Vol. II refers to Safety Criteria 7.0-1 and 7.1-3 as the safety criteria that incorporate and conform to this principle. Safety Criterion 7.0-1 states: "Normal operations shall be conducted in accordance with approved operational safety requirements and in strict accordance with administrative and procedural controls." SC 7.1-3 states, in part: "A framework shall be established for safety review organizations that are responsible for assuring the safety of the facility."

The reviewers determined that these safety criteria do not adequately incorporate and conform to this principle because the safety criteria do not address one important aspect of the principle. The criteria do not state that BNFL Inc. assumes "ultimate responsibility" for facility process safety. Additionally, the issue of full safety responsibility (ultimate responsibility) is further brought into questioned by the proposed formation of a "limited liability corporation." In correspondence subsequent to the SRD submittal (BNFL letter W338-98-0004 dated February 19, 1998), BNFL provided additional information regarding their responsibility for safety. BNFL stated that, "… we take full ownership and responsibility for the safety of the workers and the public. However, the reviewers determined that the SRD must clearly state that BNFL assumes "ultimate responsibility" for facility process safety. Additionally, no subordinate standards were identified for this principle.

Conclusions

The reviewers determined that the BNFL SRD incorporated and conforms to two of the three principles of "Overall Principles for Process Safety." BNFL did not adequately incorporate or conform to Top-Level Principle 5.1.1, "Process Safety Management," because a safety criterion has not been proposed which clearly states that BNFL Inc. has "ultimate responsibility" for facility process safety. Additionally, BNFL must incorporate applicable sections of the ISMP into the SRD as subordinate standards for the aforementioned safety criteria.

3.2.4.2 Process Safety Management Program

Requirements

DOE/RL-96-0003 states that the approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the RO that: "..2) The set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006, Revision 0.

DOE/RL-96-0006, Section 5.2, "Process Safety Management Program," contains the following twelve top-level principles relating to the process safety management program. The principles are defined as follows.

- Process Safety Information (Top-Level Principle 5.2.1): "The Contractor should develop and maintain certain important information about the process. This information is intended to provide a foundation for identifying and understanding the process hazards. The process safety information includes, but is not limited to, a summary of material data, a description of each process and its operation, and equipment design data. The information should confirm that the equipment is appropriate for the operation, its integrity is maintained, and it meets appropriate codes and standards."

- Process Hazard Analysis (Top-Level Principle 5.2.2): "The Contractor should perform a process hazards analysis (PHA) using acceptable industry practices. The process hazards analysis should be appropriate for the complexity of the process and the hazard. The Contractor should consider the effects of engineering and administrative controls, human factors, facility siting, and previous incidents in the hazard analysis. The Contractor should document the results of the hazards analysis including process hazards and possible safety and health effects. The Contractor should submit the results of the hazards analysis to the RO for evaluation and in support of authorization decisions and regulatory oversight."

One of the purposes of the hazard analysis is to evaluate the adequacy of the design and operating procedures. The Contractor should establish a system to address the findings in order to ensure that the equipment and procedures provide an adequate degree of protection against accidents. The Contractor should review and update the hazard analysis periodically to ensure that the PHA is consistent with the current process.

- Operating Procedures (Top-Level Principle 5.2.3): "The Contractor should develop and implement written operating procedures that provide clear instruction for safely conducting activities consistent with the process safety information. The procedures should address at least the following elements: steps for each operating phase of the process, operating limits, safety and health considerations, and safety systems and their functions."

- Training (Top-Level Principle 5.2.4): "Each operator should receive an overview of the process and be trained in the operating procedures. The training should include emphasis on the specific safety and health hazards, operating limits, emergency operations, and safety work practices. The employees should receive refresher training, at an appropriate frequency, considering the applicable standards and the nature of the hazards."

- Subcontractors (Top-Level Principle 5.2.5): "The Contractor may engage a subcontractor to perform maintenance, renovations, or specialty work on, or adjacent to, the process. The Contractor should inform the subcontractor of potential hazards related to the subcontractor's work and take appropriate measures to ensure that the subcontractors provide their workers with appropriate procedures and training necessary for performing their jobs safely."

- Pre-startup Safety Review (Top-Level Principle 5.2.6): "The Contractor should perform a pre-startup safety review for the facility. Pre-startup reviews also should be performed before restarting the process after significant modifications have been made to the facility. Before the introduction of hazardous materials, the pre-startup review should confirm that construction and equipment are in accordance with design specifications. It should also confirm that safety, operating, maintenance, and emergency procedures are in place; that an adequate process hazards evaluation has been performed and the recommendations resolved; and that employee training has been completed. The results of this review should be submitted to the RO for evaluation and in support of authorization decisions and regulatory oversight."

- Mechanical Integrity (Top-Level Principle 5.2.7): "The Contractor should implement a mechanical integrity program that includes written procedures, training for maintenance activities, inspection and performance testing of process equipment, and QA measures. The program should include measures to correct deficiencies in equipment that are outside acceptable limits. (*Note: A mechanical integrity program is a major and necessary element in a process safety management program because of its importance in ensuring equipment integrity; eliminating potential ignition* *sources; and determining that equipment is designed, installed, and properly operating.*)"

- Hot Work Control (Top-Level Principle 5.2.8): "The Contractor should control hot work operations performed in or near the process or facility in order to ensure that appropriate safety precautions, including fire prevention and protection, are taken before work begins."

- Management of Change (Top-Level Principle 5.2.9): "The Contractor should evaluate all planned changes involving the technology of the process and the facility design and operation in order to ensure that the impact on safety is analyzed and acceptable, and to determine the need for modifications to operating procedures. The Contractor should establish and implement written procedures to manage changes to process chemicals, technology, equipment, and procedures; and changes to facilities. These procedures should address the technical basis for the proposed changes, impact of the changes on process safety, modifications of the operating procedures, the schedule for proposed changes, and authorization for proposed changes."

- Incident Investigations (Top-Level Principle 5.2.10): "The Contractor should investigate each incident that results in, or could reasonably have resulted in, a major accident. The investigation should be conducted promptly, and appropriate corrective measures should be recommended and implemented. The results of the investigation should be submitted to the RO for evaluation and in support of regulatory oversight."

- Emergency Planning and Response (Top-Level Principle 5.2.11): "The Contractor should establish and implement an emergency action plan in accordance with the applicable standards."

- Compliance Audits (Top-Level Principle 5.2.12): "The Contractor should conduct a compliance audit periodically to certify that the procedures and practices developed under the process safety management program are adequate and adhered to. The frequency of compliance audits is based on the applicable standards and the nature of the process hazards. The Contractor should promptly determine and document an appropriate response to each finding of the compliance audit. The results of the audits should be made available to the RO in support of regulatory oversight."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles of the process safety management program contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes: (1) the Contractor's standards allow implementation of the safety principles in DOE/RL-96-0006, Section 5.2, "Process Safety Management Program," (i.e., the Contractor's standards conform to the top-level standards and principles); (2) the Contractor's standards are a set of subordinate standards and requirements that, when properly implemented, provide adequate safety, and comply with legal requirements; (3) the Contractor's standards are compatible with the overall principles; and (4) justifications regarding the implementation of individual standards and principles are documented and based on considerations of the work, associated hazards, and appropriate control of the hazards (i.e., the Contractor's standards are tailored to the hazards associated with its activities).

This examination was conducted through review of the material presented in the BNFL SRD, Vol. II, and the HAR, and the resolution of questions developed during the review.

Evaluation

The BNFL SRD, Vol. II contains the Contractor's proposed set of standards. Detailed descriptions of the safety criteria proposed by BNFL (SC 3.1-2, SC 3.1-1, SC 3.1-3, SC 3.1-4, SC 3.1-6, SC 3.1-7, SC 7.2-6, SC 7.2-4, SC 7.1-2, SC 6.0-5, SC 7.6-4, SC 4.5-19, SC 7.4-1, SC 4.0-2, SC 7.7-1, SC 7.7-2, SC 7.7-3, SC 7.8-2, and SC 7.3-10) are contained in the following paragraphs.

Process Safety Information, Top-Level Principle 5.2.1

BNFL SRD Vol. II, Safety Criterion 3.1-2 states that the purpose of the information is to enable the employer and employees involved in operating the process to identify and understand the hazards posed by those processes involving radioactive materials or highly hazardous chemicals. In its response to Question 14, BNFL has agreed to revise SC 3.1-4 (and any other safety criteria, including SC 3.1-2) to clarify that analyses are not restricted to only "highly hazardous chemicals" as defined by OSHA, but to consider all process chemicals considered to pose a hazard. The standard organizes the information to be collected into three groups as follows: (1) information pertaining to the hazards of the materials in the process; (2) information pertaining to the technology of the process; and (3) information pertaining to the equipment in the process. The reviewers determined that SC 3.1-2 conforms to Top-Level Principle 5.2.1, "Process Safety Information," because all aspects of the principle were adequately incorporated. The BNFL SRD identified no subordinate standards for this principle. However, in correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated a section of the ISMP served as the subordinate standard for this principle. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however**,** BNFL by reference must incorporate the applicable section of the ISMP into the SRD.

Process Hazard Analysis, Top-Level Principle 5.2.2

The reviewers found that Safety Criterion 3.1-1 is a proposed standard requiring performance of an initial PHA using acceptable industry standards. This safety criterion requires the PHA to document the design features that control the hazards involved in the process. Safety Criterion 3.1-3 is a proposed standard that defines the scope of process hazard analyses, including the effects of engineering and administrative controls, human factors, and facility siting; but not the effects of previous incidents. SC 3.1-4 is a proposed standard requiring the PHA to be based on an inventory of all radioactive and hazardous nonradioactive materials in the facility; and requiring the hazard analysis to identify energy sources that might contribute to the generation or uncontrolled release of those materials. Therefore, the reviewers determined that SC 3.1-1, 3.1-3 and 3.1-4 govern the scope of hazard analyses, i.e., "acceptable industry standards" aspect of the principle and the complexity aspect of the principle.

Safety Criterion 3.1-2 is a proposed standard that requires, as part of the documentation of process safety information, evaluation of the consequences of deviations, including those affecting the safety and health of employees.

SC 3.1-6 is a proposed standard requiring that a system be established to promptly address the hazard analysis team's findings, ensure that the recommendations are resolved in a timely manner, and that the resolution is documented.

SC 3.1-7 is a proposed standard requiring that at least every 5 years after completion of the initial PHA, the PHA is updated and revalidated by a qualified team to ensure it is consistent with the current process.

Therefore, the reviewers determined that SCs 3.1-1, 3.1-2, 3.1-3, 3.1-4, 3.1-6, and 3.1-7 conform with Top-Level Principle 5.2.2, "Process Hazard Analysis," because all aspects of the principle are adequately incorporated. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated a sections of the ISMP served as the subordinate standards for this principle. The reviewers determined that these ad hoc standards were adequate subordinate standards; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Operating Procedures, Top-Level Principle 5.2.3

Safety Criterion 7.2-6 is a proposed standard requiring development and implementation of written procedures and instructions to provide clear direction for safely conducting activities involving radioactive or hazardous materials. The operating modes of the process for which the procedures shall apply include initial startup, normal operations, temporary operations, emergency shutdown, emergency operations, normal shutdown, and startup following a turnaround. In addition, the safety criterion requires procedures for operating limits, safety and health considerations, and safety systems and their functions. The reviewers determined that SC 7.2-6 conforms with Top-Level Principle 5.2.3, "Operating Procedures," because all aspects of the principle were adequately incorporated. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated a section of the ISMP served as the subordinate standard for this principle. The reviewers determined that this ad hoc standard was adequate subordinate standard; however, BNFL by reference must incorporate the applicable section of the ISMP into the SRD.

Training, Top-Level Principle 5.2.4

Safety Criterion 7.2-4 is a proposed standard requiring that every employee involved in operating a process receive an overview of the process and training in the operating procedures and instructions. The training is required to emphasize the specific safety and health hazards, operating limits, emergency operations including shutdown, and safe work practices. The proposed standard requires refresher training for employees at least every 3 years, and more often if necessary. The training is required to ensure that the employee understands and adheres to the current operating procedures, and is proficient in what procedures to follow if conditions exceed the design basis of the facility. The reviewers determined that SC 7.2-4 conforms to Top-Level Principle 5.2.4, "Training," because all aspects of the principle were adequately incorporated. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated a section of the ISMP served as the subordinate standard for this principle. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable section of the ISMP into the SRD.

Subcontractors, Top-Level Principle 5.2.5

Safety Criterion 7.1-2 is a proposed standard requiring subcontractors to be informed of the known potential fire, explosion, or toxic release hazards related to the subcontractor’s work and the process. Applicable provisions of the emergency plan are to be explained to the subcontractor’s employees. “Performance of subcontractor employers with regard to safety shall be periodically evaluated.” The reviewers determined that SC 7.1-2 conforms to Top-Level Principle 5.2.5, “Subcontractors,” because all aspects of the principle were adequately incorporated. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated a section of the ISMP served as the subordinate standard for this principle. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable section of the ISMP into the SRD.

Pre-startup Safety Review, Top-Level Principle 5.2.6

Safety Criterion 6.0-5 is a proposed standard that states, “A pre-startup safety review shall be performed. The pre-startup safety review shall confirm that, prior to the introduction of radioactive or highly hazardous chemicals to a process, construction and equipment is in accordance with design specifications; safety, operating, maintenance, and emergency procedures are in place and are adequate; a process hazard analysis has been performed and recommendations have been resolved or implemented before startup; and training of each employee involved in operating a process has been completed.”

The reviewers determined that SC 6.0-5 does not conform to this principle because an aspect of the principle was not incorporated. The principle required that the Contractor submit the results of their pre-startup reviews to the Director of the Regulatory Unit for evaluation and in support of authorization decisions and regulatory oversight. In response to Question 14, BNFL has agreed to revise SC 3.1-4 (and any other safety criteria, including SC 3.1-2) to clarify that analyses are not restricted to only “highly hazardous chemicals” as defined by OSHA, but to consider all process chemicals considered to pose a hazard. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated a section of the ISMP served as the subordinate standard for this principle. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable section of the ISMP into the SRD.

Mechanical Integrity, Top-Level Principle 5.2.7

Written procedures, training for maintenance activities, inspection and performance testing of process equipment, and QA measures are captured by the SC 7.6-4 elements (5), (2), (13), and (10), respectively. The item “measures to correct deficiencies in equipment that are outside acceptable limits” in Top-Level Principle 5.2.7 is a definition of the term “maintenance.” Top-

Level Principle 5.2.7 requires that equipment shall be maintained. The reviewers determined that SC 7.6-4 conforms to Top-Level Principle 5.2.7, “Mechanical Integrity,” because all aspects of the principle were adequately incorporated. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated sections of the ISMP served as the subordinate standard for this principle. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Hot Work Control, Top-Level Principle 5.2.8

SC 4.5-19 is a proposed standard that is a restatement of Top-Level Principle 5.2.8, “Hot Work Control,” with additional requirements that hot work permits shall identify the date(s) authorized for hot work and the object on which the hot work is to be performed, and shall be kept on file until the hot work is finished. The reviewers determined that SC 4.5-19 conforms to Top-Level Principle 5.2.8, “Hot Work Control,” because all aspects of the principle were adequately incorporated. Additionally, this criterion is adequate as a subordinate standard as it describes how the program will be implemented.

Management of Change, Top-Level Principle 5.2.9

SC 7.4-1 is a proposed standard requiring a safety evaluation to determine whether a situation involves a USQ for temporary or permanent changes in the facility, as described in the existing safety analyses; or in the procedures, as derived from existing safety analyses. Tests or experiments not described in existing safety analyses also require USQ determination. This safety criterion incorporates the first requirement in Top-Level Principle 5.2.9 for the Contractor to evaluate all planned changes involving the technology of the process and the facility design and operation in order to ensure that the impact on safety is analyzed and is acceptable and to determine the need for modifications to operating procedures.

SC 4.0-2 is a proposed standard requiring that written procedures be established and implemented to manage changes (except for “replacement in kind”) to process chemicals, technology, equipment, and procedures; and changes to facilities that affect an OSHA PSM Standard “covered process,” which captures the second requirement in Top-Level Principle 5.2.9. SC 4.0-2 also specifies five considerations that are to be addressed before any change, and directs that operator employees are informed and trained before startup of the process or of the affected part of the process. The reviewers determined collectively SC 4.0-2 and SC 7.4-1 conform to Top-Level Principle 5.2.9, “Management of Change,” because all aspects of the principle were adequately incorporated. In correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated a sections of the ISMP served as the subordinate standard for this principle. The reviewers determined that this ad hoc standard was an adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Incident Investigations, Top-Level Principle 5.2.10

Safety Criteria 7.7-1, 7.7-2, and 7.7-3 are proposed standards for this principle. SC7.7-1 requires that each incident that resulted in, or could reasonably have resulted in, a major accident shall be investigated, and that the incident investigation shall be started as promptly as possible, but not later than 48 hours following the incident. This captures expectations expressed in Top-Level Principle 5.2.10, “Incident Investigation.”

SC 7.7-2 states requirements for the composition of the incident investigation team and for the content of the investigation report.

SC 7.7-3 is a proposed standard that states requirements for establishing a system to promptly address and resolve the incident report findings, and for submittal of the incident investigation report to the regulator for evaluation and in support of regulatory oversight. In addition, SC 7.7-3 requires incident reports to be retained for 5 years. The reviewers determined that collectively SC 7.7-1, SC 7.7-2, and SC 7.7-3 conform to Top-Level Principle 5.2.10, “Incident Investigation,” because all aspect of the principle were incorporated. Additionally, these criteria in conjunction with SC 7.7-4 through 7.7-9 are adequate as a subordinate standard as these criteria describe how the incident investigation program will be implemented.

Emergency Planning and Response, Top-Level Principle 5.2.11

Safety Criterion 7.8-2 is a proposed standard requiring that the Emergency Management Program will be documented in an emergency plan describing the provisions for responses to operational emergencies. The criterion specifies 12 program elements, including the establishment and maintenance of a facility emergency response organization for emergency response and mitigation, and provisions for interfaces and coordination with Hanford Site and offsite agencies in the areas of planning, preparedness, response, and recovery. The other elements of this safety criterion require, for example, provisions for assessing the consequences resulting from the release of hazardous materials, and a description of protective actions for responders, workers, and the public to include provisions for sheltering, evacuation, and personnel accountability. The reviewers determined that SC 7.8-2 conforms to Top-Level Principle 5.2.11, “Emergency Planning and Response,” because all aspects of the principle were incorporated. Additionally, this criterion in conjunction with SC 7.8-1 through 7.8-5 are adequate as a subordinate standard as these safety criteria describe how the emergency planning and response program will be implemented.

Compliance Audits, Top-Level Principle 5.2.12

SC 7.3-10 is a proposed standard that requires compliance audits to be conducted every 3 years in order to verify that the procedures and practices developed to ensure nuclear and process safety are adequate and in effect. This safety criterion requires that an appropriate response shall be determined and documented for each of the audit findings. Additionally, this criterion adds requirements concerning retention of the two most recent reports, and specifies qualifications for one of the members of the compliance audit team. The reviewers determined that SC 7.3-10 conforms to Top-Level Principle 5.2.12, “Compliance Audits,” because all aspects of the principle were adequately incorporated. However, in correspondence following the SRD submittal (BNFL letter 5193-98-0023 dated January 26, 1998), BNFL provided additional information regarding a subordinate standard for this principle. In this correspondence BNFL stated a section of the ISMP served as the subordinate standard for this principle. The reviewers determined that this ad hoc standard was adequate subordinate standard; however, BNFL by reference must incorporate the applicable sections of the ISMP into the SRD.

Conclusions

The reviewers concluded that the SRD adequately incorporates and conforms to 11 of the 12 Top-Level Principles of "General Process Safety." The BNFL SRD does not conform to Top-Level Principle 5.2.6, "Pre-startup Safety Review," because SC 6.0-5 does not require that the Contractor submit the results of their pre-startup reviews to the Director of the Regulatory Unit for evaluation and in support of authorization decisions and regulatory oversight. Additionally, the SRD does not include subordinate standards for 9 of 12 top-level principles. By reference, BNFL must incorporate applicable section of the ISMP in the SRD as subordinate standards.

3.3 Assessment of Facility Hazards and Operations Hazards

3.3.1 Review of Process, Facility, and Site Descriptions

Requirements

DOE/RL-96-0003, Section 3.3.1, states that the approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the RO that: "...3) The hazards associated with the proposed facility and its operation are appropriately assessed." In addition, DOE/RL-96-0003, Section 4.1.2, "Contractor Input," requires that: "The Standards Approval submittal package shall consist of the following documentation: ...5) Description of the process and facility design and its proposed operation."

Review Methodology

The purpose of this section is to verify that the Contractor's SA Package satisfies the submittal requirement cited above and to determine if the submittal contains sufficient detail to support the required determination that the hazards associated with the proposed facility and its operation are appropriately assessed. The characteristics of the process, facility, and site should be described in sufficient detail to support hazards identification, hazards characterization, and decision making to control the hazards. More specifically, the reviewers considered the following characteristics or attributes from DOE/RL-97-08, Section 8.1, p. 22, in conducting their review of the process, facility, and site descriptions.

- "Process Descriptions: The Contractor's descriptions of its planned tank waste treatment processes include the basic function and theories of each process in sufficient detail to support hazards identification, hazards characterization, and risk-informed decision making to control the hazards.

- Systems Descriptions: The Contractor's descriptions of planned tank waste treatment systems include the basic functions of the systems, the key components/equipment (e.g., sizes, inventories, etc.); operating characteristics (e.g., batch, continuous, chemicals involved and their concentrations, radionuclides involved and their concentrations, etc.); and approximate operating ranges and limits (e.g., pressures, temperatures, processed material states, flow rates, etc.); in sufficient detail to support hazards identification, hazards characterization, and risk-informed decision making to control the hazards.

- Facility Description: The Contractor's description of the facility includes the purpose and function of each building, design information regarding the facility's resistance to the effects of external events, location and arrangement of the buildings on the site and their distance from the facility fence and site boundary, and other features (if any) that could affect hazards identification, hazards characterization, and risk-informed decision making to control the hazards.

- Site Description: The Contractor's description of the site includes, as appropriate, the site geography, demography, meteorology, hydrology, geology, and seismology sufficient to support hazards identification, hazards characterization, and risk-informed decision making to control the hazards. Man-made external events that contribute to the hazards posed to the facility workers or that could contribute to the "release" of the hazards associated with the facility should be included. If information from sources at the Hanford Site is used, it should be referenced and include the characteristics of and rationale for the selected external events and selected receptors.

- Operational Scenarios (Modes): The Contractor's description of the intended operational scenarios includes normal operations and anticipated events (internal and external) sufficient to support hazards identification, hazards characterization, and risk-informed decision making to control the hazards. This description should include startup, shutdown, maintenance/equipment changeout, processing cycles (if batch-type), and off-normal events, particularly as they relate to hazards that differ from those associated with steady-state operation and to different utilization of operating personnel.

- Design Status: The Contractor's identification of work based on the maturity of design is not anticipated to change in a manner sufficient to invalidate the hazard assessment.

- Uncertainties: The Contractor's summary of uncertainties in tank waste treatment process or design addresses the potential for significantly changing the hazards-based activities that are the subject of the Standards Approval Review."

In evaluating the design status and uncertainties, the reviewers noted any specific changes and uncertainties identified by the Contractor. Where the submittal does not explicitly address the design status and uncertainties, the reviewers used their professional judgement to identify any areas where the design status was considered to be uncertain and likely to change in a way that might invalidate the hazards assessment.

<u>Evaluation</u>

This segment of the review focused on the description of the process, processing systems, and their operation as they relate to the identification and assessment of hazards in the TWRS-P facility. Identification and assessment of hazards in facility structures other than those facilities that house the waste processing operations were considered less extensively. Consistent with this consideration, the following evaluation is presented from an "inside to outside" perspective (i.e., process description followed by the facility and site descriptions).

3.3.1.1 Process Description

BNFL divided the process into a number of "process steps." The following evaluation of the process description addresses each of these process steps.

3.3.1.1.1 Waste Receipt

The reviewers evaluated the process descriptions for feed receipt tanks presented in the BNFL HAR, Sections 2.3.1, "Waste Receipt," 5.2.1, "LAW Feed Receipt," and 5.2.4, "HLW Feed Receipt and Pretreatment System." System descriptions include discussion of the LAW double-shell tank (DST), feed receipt tank, associated transfer lines from the DST to the treatment facility, and the HLW feed receipt tanks within the treatment facility. The approximate sizes of the tanks are provided and their functions are discussed. Support systems associated with the tanks, such as the DST ventilation system and the cooling coils for the HLW feed receipt tanks, are briefly mentioned in the BNFL HAR. The estimates of the major radionuclide inventories contained in the various feed tanks are provided in the BNFL HAR, Table 4.1.

Additional information regarding conceptual design for the buffer tank (DST 241-AP-106) is provided in the BNFL document, "TWRS Hanford Basis of Design (LAW and HLW)," K0104_REP_002_PRC, 14 Sept. 1997, Section 3.1 and Appendix 3. The Contractor describes and illustrates buildings to be constructed in or near the AP Tank Farm area. Modifications and additions to the tank pump pits, including the addition of a mixer pump and transfer pumps to facilitate transfer to the vitrification facility, are discussed and illustrated. Modifications to the existing ventilation systems are described. New instrumentation and the overall process control philosophy are discussed at length. Treatment plant double-contained transfer lines are described briefly.

The BNFL submittal was unclear regarding components involved in the HLW feed receipt. This problem was satisfactorily addressed in BNFL's response to Question 131. Also, the initial version of Table 4.1 contained errors in the inventories for cesium and strontium. These errors were corrected and a revised Table 4.1 was submitted as part of the response to review Question 21.

3.3.1.1.2 LAW Feed Evaporation and Solids Removal

This examination was conducted through review of the material presented in the BNFL HAR, and BNFL concept process flow diagram (PFD) drawings ("TWRS Hanford Basis of Design [LAW and HLW]," K0104_REP_002_PRC, 14 Sept. 1997).

The BNFL HAR, Sections 2.3.2, "LAW Feed Evaporator" and 2.3.3, "Solids Removal by Ultrafiltration" provide initial statements of purpose for the evaporator and ultrafilter, respectively. Sections 5.2.2, "LAW Feed Receipt Evaporator," and 5.2.3, "Entrained Solids Removal System," provide additional technical details. Summary information such as subsystem temperatures and pressures and stream conditions are also provided. Concept process flow diagram drawings provided by BNFL were available and utilized by the reviewers to obtain additional details such as the use, location, and sequencing of subsystems, support vessels, and utilities.

The reviewers found that the subsystem selections and operating bases are described in detail. The theories of operation are sufficiently detailed in the areas of process operations and stream conditions. The slurry chemical and physical behavior, particularly saturation and precipitation conditions and rheological behavior, were identified by the reviewers as significant technical areas. These areas are important for defining maximum concentration conditions, production capacities, and process efficiencies. Detailed discussions were not included for the LAW feed evaporation system or the solids removal system. The reviewers considered the absence of this information consistent with pre-conceptual design, and not essential to support initial identification and assessment of the hazards.

The material provided by BNFL adequately describes key components and equipment involved as well as the operating characteristics and approximate operating conditions (i.e., temperatures and pressures) of the steady-state nominal case. Comprehensive operating ranges and limits for the equipment, such as temperature, pressure, flow rate, and maximum solids concentrations, were not discussed in the HAR. The reviewers considered the absence of this information consistent with the pre-conceptual design, and not essential to support initial identification and assessment of the hazards.

To determine the adequacy of intended operational scenarios (modes), the reviewers assessed the materials described above as well as the BNFL HAR, Appendix A, “Maintenance Fault Schedules,” and Appendix B, “Operability Fault Schedules.” The operational scenarios (modes) include startup, shutdown, maintenance/equipment changeout, processing cycles, and off-normal events, particularly as they relate to hazards that differ from those associated with steady-state operation and to a different utilization of operating personnel. The LAW evaporator and ultrafiltration subsystems operate continuously, although the ultrafiltration subsystems operate in a continuous batch mode. Startup and shutdown activities, except as they relate to equipment maintenance or changeout, are not significant accident initiators. Normal and off-normal initiating events are identified as initiating events in the Fault Schedules and in the HAR Appendices. The reviewers determined that the HAR identified sufficient bounding cases which adequately bracket the magnitude of potential hazards and resulting consequences. A thorough, documented review of subsystem startup, shutdown, maintenance/equipment changeout, processing cycles, and off-normal conditions should be developed during detailed design, after final equipment selection and sizing.

The level of design maturity appears to be adequate. Thus, it can be concluded that future design changes should not introduce new and significant hazards that will invalidate the current hazards identification and assessment. This is predicated on the expectation that no subsystems will be replaced, new hazard sources will not be introduced, and the material process flows will not significantly increase.

3.3.1.1.3 Cesium and Technetium Removal

The reviewers evaluated the BNFL HAR, Sections 2.2.4, “Glass Formers Storage Building,” 5.2.5, “Cesium Removal Using Ion Exchange,” and 5.2.7, “Technetium Removal Using Ion Exchange,” which describe the ion exchange process for cesium and technetium removal. In addition, the reviewers examined the PFDs, which illustrate cesium and technetium removal during the pretreatment process (“TWRS Hanford Basis of Design [LAW and HLW],” K0104_REP_002_PRC, 14 Sept. 1997 - PFD 2200, DRG. No. O/BE/1614659 and PFD 2600, DRG. No. O/BE/1614664).

Characteristics of the ion-exchange systems and their operating conditions (column sizes, number of columns, and provisions for column loading and elution/regeneration) that could affect hazards identification, hazards characterization, and decision making to control the hazards are described. Specifically, descriptions are included for the proposed operations (reagent makeup and loading, rinsing, elution, and regeneration of the ion exchange columns) and associated provisions to avoid exothermic acid/base reactions in the columns and to remove radioactive decay heat. Nominal mass and radionuclide balance information based on numerical simulation of the process are provided ("TWRS Hanford Basis of Design [LAW and HLW]," K0104_REP_002_PRC, 14 Sept. 1997). Also, in response to Question 129, BNFL provided an estimate of the cesium inventory on a fully-loaded ion-exchange column.

The reviewers determined that the description of the cesium and technetium removal system is sufficiently detailed to support identification and assessment of the hazards commensurate with the current level of design development. The level of design maturity appears to be adequate. Thus, the reviewers concluded that future design changes should not introduce new and significant hazards that will invalidate the current hazards identification and assessment.

3.3.1.1.4 Nitric Acid Recovery and Resin Addition

The reviewers evaluated the BNFL HAR, Sections 2.3.5, "Cesium/Technetium Nitric Acid Recovery," and 5.2.8, "Cesium/Technetium Nitric Acid Recovery System," which describe the processes for concentrating and recovering nitric acid from the cesium and technetium ion exchange eluates. Section 5.2.9, "Cesium/Technetium Fresh Resin Addition," which describes the fresh resin addition, spent resin removal from the ion-exchange columns, and its subsequent disposition by blending with the LAW melter feed, was also evaluated. The evaluations included review of the PFDs for these systems (Ref, for Vol. 4; PFD2300, DRG. No. O/BE/1614663; PFD2700, DRG. No. O/BE/1614667; PFD2800, DRG. No. O/BE/1614669; PFD2900, DRG. No. O/BE/1614670).

Characteristics of the eluate evaporators, reflux columns, and condensers and their operating conditions (pressure, nitric acid concentration, and steam condensate radionuclide concentration) that could affect hazards identification, hazards characterization, and decision making to control the hazards are described. In addition, other features (i.e., sizes and bounding estimates of the separated cesium inventories that are to be stored in the facility for the HLW/LAW and LAW-only options, and disposition of spent ion-exchange resins by blending with the feed to the LAW melters) of the cesium/technetium acid recovery and fresh resin addition systems that could affect hazards identification, hazards characterization, and decision making to control the hazards are described. Estimates of the inventories of concentrated cesium and technetium solutions that may be stored in these systems are provided in the BNFL HAR Table 4-1. Mass and radionuclide balance information ("TWRS Hanford Basis of Design [LAW and HLW]," K0104_REP_002_PRC, 14 Sept. 1997) based on numerical simulation of the process is provided. In response to Question 128, BNFL resolved discrepancies in the submission concerning the disposition of the spent ion-exchange resin. The issues of accumulation and storage of the separated cesium for LAW/HLW and LAW-only options were clarified in the response to Questions 28, 30, and 31.

The reviewers determined that the description of the nitric acid recovery and resin addition systems was sufficient to support identification and assessment of the hazards commensurate with the current level of design development. Thus, the reviewers concluded that future design changes should not introduce new and significant hazards that will invalidate the current hazards identification and assessment.

In contrast, the reviewers noted that, at this early stage of design, the hazards associated with disposition of the spent resin by incineration in the LAW melters are uncertain (see Question 128) and could lead to the need for BNFL to adopt an alternative disposal option.

3.3.1.1.5 Cesium Recovery as a Solid

The reviewers evaluated the BNFL HAR, Sections 2.3.6, "Cesium Recovery as a Solid," and 5.2.6, "Cesium Recovery as a Solid – LAW only," which describe the processes for recovery of the separated cesium as a dry, free-flowing solid (LAW-only option). The reviewers also evaluated the PFD which illustrates the process ("TWRS Hanford Basis of Design [LAW and HLW]," K0104_REP_002_PRC, 14 Sept. 1997; PFD 2400, DRG. No. O/BE/1614662).

Recovery of cesium as a solid involves neutralization of the concentrated cesium eluate from the cesium/technetium nitric acid recovery system and adsorption of the cesium from the neutralized solution onto a crystalline silicotitanate (CST) ion-exchange material. The CST material is then dried and loaded into sealed canisters for return to the DOE. Features of the process and processing operations (temperature in the neutralization vessel, provisions for cooling water and radiation monitoring for the cooling water return lines, provisions for spill collection and detection, remote handling with provisions to prevent a canister from being dropped onto the neutralization vessel, provisions for water removal from the cesium-loaded CST, and canister sealing to prevent release of contamination) that could affect hazards identification, hazards characterization, and decision making to control the hazards are described. Estimates of the cesium inventory (6.0×10^3 terabecquerel [TBq]) and heat output (0.8 kilowatt) per canister of CST are also provided. These estimates are appropriate for initial identification and assessment of the hazards. In response to Question 32, BNFL clarified how the effectiveness of the CST drying conditions will be determined, in light of the potential hazards associated with radiolytic hydrogen generation from bound water in the CST.

The reviewers determined that the description of the process system for cesium recovery as a solid is sufficiently detailed to support identification and assessment of the hazards commensurate with the current level of design development. The level of design maturity appears to be adequate. Thus, the reviewers concluded that future design changes should not introduce new and significant hazards that will invalidate the current hazards identification and assessment.

3.3.1.1.6 LAW Melter Feed Evaporation

This examination was conducted through review of the material presented in the BNFL HAR and concept PFD drawings.

The evaporator is described in the BNFL HAR, Section 2.3.7, "LAW Melter Feed Evaporator." A detailed description of the subsystems is provided in Section 5.2.10, "LAW Melter Feed Evaporator." Information is provided on process stream routing, temperature and pressure information, and LAW stream characteristics. In addition, concept PFDs ("TWRS Hanford Basis of Design [LAW and HLW]," K0104_REP_002_PRC, 14 Sept. 1997) were used by the reviewers to obtain additional details such as the use, location, and sequencing of subsystems, support vessels, and utilities.

The reviewers found that the subsystem selections and operating bases are described in sufficient detail to support hazards identification and assessment. The theories of operation are sufficiently detailed to establish the physical and chemical state of the LAW stream throughout the evaporator cycle. The BNFL submission adequately describes key components and equipment involved as well as the operating characteristics and approximate operating conditions (i.e., temperatures and pressures) of the steady-state nominal case. Process tank capacities and minimum and maximum pressure and temperature data are also presented in the PFDs. The reviewers noted that comprehensive operating ranges and limits for the equipment, such as temperatures, pressures, flow rates, and maximum solids concentrations, are not provided in the BNFL HAR. The absence of this information is consistent with the current level of design development and not essential to support initial identification and assessment of the hazards.

To determine the adequacy of intended operational scenarios (modes), particularly as they relate to hazards that differ from those associated with steady-state operation and to the different utilization of operating personnel, the reviewers assessed the materials described above as well as the BNFL HAR, Appendix A, "Maintenance Fault Schedules," and Appendix B, "Operability Fault Schedules." The intended operational scenarios (modes) include startup, shutdown, maintenance/equipment changeout, processing cycles, and off-normal events. The evaporation subsystems operate continuously. Startup and shutdown activities, except as they relate to equipment maintenance or changeout, are not significant accident initiators. Normal and off-normal initiating events are identified in the fault schedules and the appendices as initiating events. The reviewers determined that sufficient bounding cases were identified to adequately bound the magnitude of the hazards and the associated accident consequences. A thorough review of subsystem startup, shutdown, maintenance/equipment changeout, processing cycles, and off-normal conditions should be developed later in the design phase, after final equipment selection and sizing.

The level of design detail appears to be adequate. Thus, it can be concluded that future design changes should not introduce new and significant hazards that will invalidate the current assessment. This is predicated on the expectations that no subsystems will be replaced, new hazard sources will not be introduced, and the material process flows will not significantly increase.

3.3.1.1.7 LAW and HLW Glass Melters

This evaluation was conducted through review of the material presented in the BNFL HAR and BNFL concept PFD drawings. Review of the LAW and HLW melters was conducted concurrently because of the similarity of the systems and the fact that the descriptions were found to be complementary in several situations.

General overviews of the LAW and HLW glass melter systems are provided in the BNFL HAR, Section 2.3.8, "LAW Glass Melter," and Section 2.3.9, "HLW Glass Melter." The melter systems are defined here as the dry chemical preparation system, the blending operations of the dry chemicals with the waste(s), and the melters. Sections 5.2.11, "LAW Melter System," and 5.2.13, "HLW Melter System," provide a more thorough description, as well as technical details of the LAW and HLW melter systems. The BNFL HAR, Section 4, "Hazard Identification," provides anticipated chemical and radiochemical inventories for the various unit operations. In addition, PFDs ("TWRS Hanford Basis of Design [LAW and HLW]," K0104_REP_002_PRC, 14 Sept.

1997) were evaluated by the reviewers to obtain additional details such as the facility layout, vessel connections, line routings, and vessel capacities.

The reviewers found the description of the overall process adequate to support hazards identification and characterization. The BNFL submission adequately describes key components and equipment involved, as well as the operating characteristics and nominal operating conditions (e.g., target temperatures and flow rates) of the steady-state case. The submittal also contains expected sizes and flow rates for major pieces of equipment such as the melters and the HLW feed preparation tanks. Similar information for the LAW feed preparation tanks was absent; however, the reviewers did not consider this omission to be critical to the hazards review due to the early stage of design and required revisions to the hazards analysis. The anticipated chemical and radiochemical inventories of the dry chemical systems and the melters were provided in HAR, Chapter 4. The reviewers noted that comprehensive safe operating ranges and limits for the equipment, such as temperature, pressure, and flow rate, were not provided in the HAR. The absence of this information was considered consistent with the current level of design development, and not essential to support initial identification and assessment of the hazards.

The materials described above, as well as Appendix A, “Maintenance Fault Schedules,” and Appendix B, “Operability Fault Schedules,” were reviewed for their adequacy in describing normal and off-normal operating scenarios. Only a few off-normal operating events (failure of agitation, loss of melter cooling, and melter pressurization) are identified in the process descriptions. Normal and off-normal initiating events are identified in the Fault Schedules and in Appendices A and B as initiating events. Shutdown of the melters is adequately described in the text, but there is no discussion on startup of the melters. The reviewers determined that sufficient bounding cases were identified to adequately bound the magnitude of potential hazards and resulting consequences via the fault schedules. However, a thorough, documented review of subsystems startup, maintenance/equipment changeout, processing cycles, and off-normal conditions should be developed later in the design phase, after final equipment selection and sizing.

The design detail was adequate. Thus, the reviewers concluded that future design changes should not introduce new and significant hazards that will invalidate the current assessment. This is predicated on the expectation that no subsystems will be replaced, new hazard sources will not be introduced, and the material process flows will not significantly increase.

3.3.1.1.8 Vitrification Offgas Treatment

This examination was conducted through review of the material presented in the BNFL HAR, and BNFL concept PFDs drawings.

A general description of the offgas constituents and the subsystems that comprise the LAW and HAW offgas treatment process is provided in the BNFL HAR, Section 2.3.10, “Vitrification Offgas Treatment,.” Sections 5.2.12, “LAW Vitrification Offgas Treatment and Emergency Offgas System,” and 5.2.14, “HLW Vitrification Offgas Treatment System,” provide added subsystem technical details on the LAW and HLW primary and emergency offgas treatment systems, respectively. Summary information such as stream temperatures and volumetric flow rates, method of particulate or gaseous capture or conversion, and maintenance requirements are provided. In addition, concept PFD drawings (“TWRS Hanford Basis of Design [LAW and HLW],” K0104_REP_002_PRC, 14 Sept. 1997) were examined by the reviewers to obtain added details such as the use, location, and sequencing of instrumentation, subsystems, support vessels, and utilities.

The reviewers found that the subsystem selections and operating bases are described in sufficient detail to support hazards identification and assessment. The theories of operation are summarized and do not describe the specific physical and chemical principals that control or limit the subsystem's methods of capture or conversion and retention of components in the offgas stream. Details of these theories are thoroughly documented in the published literature.

The HAR adequately describes key components and equipment involved, as well as the operating characteristics and approximate operating conditions (e.g., temperatures and flow rates) for the steady-state nominal case. Some detailed mass and energy balance data are also presented in the PFDs. Comprehensive operating ranges and limits for the equipment, such as temperatures, pressures, flow rates, and maximum particulate, aerosol, or gaseous concentrations, are not provided in the HAR. The reviewers determined that the absence of this information was consistent with the current level of design development, and not essential to support initial identification and assessment of the hazards.

To determine the adequacy of intended operational scenarios (modes), particularly as they relate to hazards that differ from those associated with steady-state operation and to the different utilization of operating personnel, the reviewers assessed the materials described above, as well as Appendix A, "Maintenance Fault Schedules," and Appendix B, "Operability Fault Schedules" in the BNFL HAR. The intended operational scenarios (modes) include startup, shutdown, maintenance/equipment changeout, processing cycles, and off-normal events. The offgas treatment subsystems operate continuously. Startup and shutdown activities, except as they relate to equipment maintenance or changeout, are not significant hazard initiators. Accident initiating events associated with normal and off-normal operations are identified in the fault schedules and in Appendices A and B. It is the reviewers' judgment that sufficient bounding cases are identified to adequately bracket the magnitude of potential hazards and resulting consequences. However, a thorough, documented review of subsystem startup, shutdown, maintenance/equipment changeout, processing cycles, and off-normal conditions should be developed later in the design phase, after final equipment selection and sizing.

The level of design detail appears to be adequate. The reviewers concluded that future design changes should not introduce new and significant hazards that will invalidate the current assessment. This is predicated on the expectation that no subsystems will be replaced, new hazard sources will not be introduced, and the material process flows will not significantly increase.

3.3.1.1.9 Container Decontamination

The reviewers evaluated the process descriptions for container decontamination in the BNFL HAR, Sections 2.3.11, "Container Decontamination," and 5.2.16, "LAW/HLW Container Decontamination System."

The process description includes an outline of the major container movement and washing operations and a brief discussion of return procedures for canisters that fail to meet the acceptance criteria after initial washing. The process for container decontamination is described in sufficient detail to support the assessment of hazards for the process.

System descriptions are relatively detailed. Canisters are subjected to ultra-high pressure water washing within a containment enclosure identified as the decontamination booth. The effluent streams produced by the washing process are identified in sufficient detail to support the hazard assessment. The feed and catch tanks for decontamination water are described. The ultra-high pressure water components discussed include a reverse osmosis pump to purify demineralized water feed to the ultra-high pressure washing system, the ultra-high pressure intensifier pump, ultra-high pressure water lines into the decontamination booth, and spray guns used to produce jets of ultra-high pressure water. The description of ultra-high pressure water components is sufficiently detailed to allow the identification of potential component failures and other hazards associated with this high-energy system.

3.3.1.1.10 Support Systems

The reviewers evaluated the descriptions of the Contractor's TWRS-P support systems provided in the BNFL HAR, Section 2.3.12. The BNFL HAR identifies systems for the supply and delivery of chemicals, and for the treatment and routing of gaseous and liquid effluents from the various process steps. The support systems include the LAW/HLW vitrification emergency offgas system described in the following sections in the BNFL HAR:

- Section 5.2.12, "LAW Vitrification Offgas Treatment and Emergency Offgas Systems," and in PFD 1614687
- Section 5.2.15, "Secondary Offgas Treatment System"
- Section 5.2.17, "Plant Waste Management System"
- Section 5.2.18, "Outcell Process Reagents System"
- Section 5.2.19, "Boiler Water Heat Recovery System"
- Section 5.2.20, "Mechanical Handling System"
- Section 5.2.21, "Heating, Ventilation, and Air-conditioning (HVAC) Systems."

The identification of work for the support systems was the basis for the corresponding hazards assessment documented in the fault schedules.

The Contractor committed to providing additional descriptive information to support a more extensive hazards assessment as the design matures (*TWRS-P Project Safety Requirements Document*, the SRD, Vol. I, Section, 3.6, "Maintenance of the SRD").

3.3.1.2 Facility Description

This section of the evaluation considers the descriptions provided in the submission for the buildings in the TWRS-P complex.

3.3.1.2.1 Radioactive Waste Treatment Building

The reviewers evaluated HAR, Section 2.2.1, "Radioactive Waste Treatment Building."

The location of the Radioactive Waste Treatment Building is identified in the BNFL HAR, Figure 2-2. The purpose of the building is to house processes for pretreatment and vitrification of the waste feed materials for the LAW-only and for the HLW/LAW options. The description in the BNFL HAR provides the dimensions and illustrates the physical layout of the building as it would be configured for each of these options. Additional detail regarding the building and equipment layout is provided in BNFL's "TWRS Hanford Basis of Design (LAW and HLW)," K0104_REP_002_PRC, 14 Sept. 1997. Features of the building that could affect hazards identification, assessment, and decision making to control the hazards are described. Specifically, the pretreatment and vitrification processes (See Section 3.3.1.1) will be conducted remotely in stainless steel-lined concrete cells. Process equipment that may require inspection and maintenance (e.g., pumps and valves) will be located in shielded areas (referred to as " bulges") adjacent to the cells. These bulges are designed to facilitate access for inspection and maintenance. The principal radioactive and hazardous materials, chemical interactions, and energy sources that constitute hazards in the building are associated with the process equipment discussed above in Section 3.3.1.1.

3.3.1.2.2 Immobilized Waste Container Shipping Building

The reviewers evaluated HAR, Section 2.2.2, "Immobilized Waste Container Shipping Building." The function of this building is to provide for loading of the LAW and separated cesium (LAW-only option) products into shipping containers that are then loaded onto transport vehicles and delivered to the DOE. The location and size of the building are described, as well as some features of the building that could affect hazards identification and assessment and risk-informed decision making to control the hazards. Specifically, the Contractor describes how shielded flasks are to be used for transfer of the waste products through an underground tunnel from the Radioactive Waste Treatment Building. Insufficient information was provided to support identification and assessment of the hazards in this building. Neither the building radioactive materials inventories nor the transfer operations and equipment are described. The reviewers considered the absence of this information consistent with the current level of design development, reflecting appropriate focus on identification and assessment of the more significant process hazards.

3.3.1.2.3 Wet Chemical Storage Building

The reviewers evaluated the BNFL HAR, Section 2.2.3, "Wet Chemical Storage Building." The purpose of the building, as stated in the HAR, is to store bulk chemical reagents in aqueous solution, anhydrous (liquid) ammonia, dry chemicals, and fresh ion-exchange resins. The location and dimensions of the building are provided. Features of the building that could affect hazards assessment and risk-informed decision making are described as follows: the operations conducted in the building, including storage, weighing, blending, and pneumatic transfer; the chemicals stored in the building; the double-door airlock to the Waste Treatment Building and the interlock with the roll-up door; the environmentally-controlled storage area for the protection of ion-exchange resins; and the spill retention basins for the liquid reagents. The types, quantities, and forms of process chemicals stored in the building are listed in the BNFL HAR, Table 4-2. The current level of design is insufficient to perform a hazard analysis for bulk ("cold") chemical storage that is similar to that performed for the core radioactive waste processing portions of the TWRS-P process. The reviewers noted that BNFL had performed a preliminary safety review of TWRS-P bulk chemical storage systems to indicate hazards and concerns that would need to be addressed via a more formal means when greater design detail was available.

In discussion with the reviewers, the Contractor's representatives indicated that urea (possibly in aqueous solution) is under consideration in place of anhydrous ammonia to generate ammonia for the selective catalytic reduction process for removing oxides of nitrogen ($NO_{x)}$ from the LAW melter offgas stream. In that case, the design of the Wet Chemical Storage Building will be revised to eliminate the anhydrous ammonia storage tank. Thus, the Contractor's identification of work based on the maturity of design may change in a manner that will require revision of this section of the HAR, and a corresponding revision of the hazards assessment. The Contractor has committed to revise the hazards assessment as the design matures (the BNFL SRD, Vol. I, Section 3.6, "Maintenance of the SRD").

3.3.1.2.4 Glass Formers Storage Building

The reviewers evaluated the BNFL HAR, Section 2.2.4, "Glass Formers Storage Building." The description includes the location, dimensions, and purpose of the building. As stated in the HAR, the building's purpose is to store bulk glass chemicals. Features of the building that could affect hazard assessment and risk-informed decision-making are operations conducted in the building, including storage, weighing, blending, and pneumatic transfer; and the chemicals stored in the building. The types and quantities of process chemicals stored in the building are listed in the BNFL HAR, Table 4-2. At this time, the level of design for bulk ("cold") chemical storage is insufficient to perform a hazard analysis similar to that performed for the core radioactive waste processing portions of the TWRS-P process. The Contractor has committed to revise the hazards assessment as the design matures (BNFL SRD, Vol. I, Section 3.6, "Maintenance of the SRD").

3.3.1.2.5 Other Buildings

The reviewers evaluated the BNFL HAR, Section 2.2.5, "Other Buildings" that included brief descriptions of the Melter Assembly Building, Empty Container Storage Building, Services Building, and Administration Building. The location of, purpose of, and operations conducted in, each building are identified. It is noted in the HAR that these buildings are not included in the hazard assessment, as they do not contain significant quantities of hazardous materials.

3.3.1.3 Site Description

The reviewers evaluated HAR, Section 2.1, "Site Description." The description summarizes features of the site geography and demography; natural phenomena (meteorology, hydrology, seismicity, volcanism, and subsurface stability); and nearby facilities (200 East Area facilities and nearby industry) and transportation that are pertinent to identifying external events (natural phenomena and man-made) that may contribute to the risks posed by the TWRS-P facility. The following paragraphs describe the significant external events and their consideration in the assessment and control of the TWRS-P facility hazards.

As described in the HAR, the site is located in the 200 East Area of the Hanford Site (see Figure 2-1 for a map of the Hanford Site). The description includes the pertinent site demographics and a summary of the population distribution in the area surrounding the Hanford Site. The description also identifies the approximate number of Hanford Site workers (15,000) and the number of these workers (500) who work at the east end of the 200 East Area near the TWRS-P facility site. The reviewers determined that the description of the site location and demographics contains sufficient detail to support the hazards assessment.

The description of the site meteorology includes a summary of the highest recorded peak wind speeds at the Hanford Site. It identifies the design basis straight wind speeds and wind-blown missile velocities for TWRS-P structures that are classified as Design Class I. Because of the low annual probability and low wind speeds for tornadoes at the Hanford Site, no tornado design requirements are to be applied. The average and range of the annual rainfall and snowfall data recorded for the Site are described. Design basis rainfall precipitation rates and snow loads to be used for Design Class I and II structures are provided. The reviewers determined that the description of the site meteorology and the BNFL approach to designing the TWRS-P Design Class I and II structures to withstand meteorological loads that exceed any recorded at the Hanford Site are appropriate. However, the reviewers considered that the natural phenomena hazards (NPH) design criteria described in the HAR requires further justification (see Section 3.6.2.1, "General Design"); BNFL agreed to provide the needed site-specific justification in the BNFL ISAR.

The submittal describes the maximum flood levels that could result from flooding of the Columbia and Yakima Rivers and the ephemeral streams in the Yakima River drainage basin. It also describes flooding associated with failure scenarios for the dams on the Columbia River. Pertinent information is presented to support the Contractor's conclusion that the elevation of the TWRS-P site, together with the protection afforded by an existing drainage divide against flooding in the Yakima River drainage basin, make flooding of the site unlikely. The reviewers determined that the description of potential flooding events was sufficiently detailed for the current level of design development.

The HAR summarizes seismic sources and the response characteristics of the soils underlying the 200 East Area. Site-specific seismic hazard studies performed in 1996 are referenced. Design basis seismic requirements for TWRS-P SSCs classified as Design Class I and II are identified. The reviewers noted that the selected seismic design criteria identified in the HAR require further justification. BNFL agreed to provide the needed site-specific justification in the BNFL ISAR. The reviewers determined that the description and consideration of seismic events provided in the HAR are appropriate for assessing the TWRS-P hazards at the current stage of design development.

Ashfall associated with volcanism in the Cascade Range is identified as the principal volcanic hazard affecting the site. The results from cited U.S. Geological Survey studies of hazards associated with volcanism in the Cascade Range were used to identify design basis ashfall loads for TWRS-P Design Class I (61 kg/m^2) and Design Class II (24 kg/m^2) structures. The reviewers judged that the description and consideration of volcanism provided in the BNFL HAR are appropriate for assessing the TWRS-P hazards at the current stage of design development.

The HAR describes man-made external events by considering how other facilities in the 200 East Area, transportation, and nearby industry may contribute to the TWRS-P hazards. The principal effect identified for other facilities in the 200 East Area is the possible need to evacuate the TWRS-P facility as a result of accidental releases of radioactive or hazardous materials from these facilities. The HAR also includes a summary of the road, rail, barge, and air transportation in the vicinity of the site. An acceptable basis is provided for the conclusion that explosions or toxic chemical releases from transportation accidents present a negligible risk to the TWRS-P facility. In addition, the preliminary conclusion (to be revisited in the PSAR) that aircraft impacts are unlikely and that the expected robustness of the TWRS-P processing facility structures, where potentially hazardous operations would be performed, could withstand the impact of aircraft crash missiles is appropriate for consideration of the hazards at the current level of conceptual design. The most significant external hazard that might result from activities at nearby industrial and military facilities is identified as a brush fire which, under adverse meteorological conditions, could spread rapidly to the TWRS-P facility. Measures being taken to reduce the spread of fire hazards are outlined in the BNFL HAR. The reviewers determined that the description and consideration of man-made external events are appropriate for assessing the TWRS-P hazards at the current stage of design development.

Conclusions

The reviewers determined that (1) the Contractor's SA Package for the facility and process description satisfied the submittal requirement, and (2) the Contractor's process, facility, and site description includes sufficient detail to support hazards identification, hazards characterization, and identification of appropriate suites of candidate hazard controls commensurate with the current level of conceptual design.

Although the Contractor's description of the TWRS-P process, facilities, and site is based on a conceptual design, the reviewers considered the BNFL processing technologies and process designs sufficiently mature so that change would not invalidate the hazards identification and assessment. The reviewers noted that the Contractor does not provide a specific summary of uncertainties in process or design which could significantly change the hazards identification and assessment. This is acceptable because the Contractor is required to reassess the hazards as the design progresses (BNFL SRD, Vol. I, Section 3.6, "Maintenance of the SRD").

The reviewers determined that the Contractor's focus on the identification, assessment, and control of the hazards associated with the process was appropriate for the current stage of design development. The reviewers noted that with the exception of the Radioactive Waste Treatment Building (which houses the processing equipment), the descriptions of the TWRS-P facility buildings were insufficient to support identification and assessment of the facility hazards (see Question 33). The reviewers also noted that unlikely external events, beyond those that were considered in developing the design basis criteria for external events, were not considered in the hazards assessment. The reviewers considered these omissions acceptable at the current stage of design because the Contractor is required to reassess the hazards as the design progresses (BNFL SRD, Vol. I, Section 3.6, "Maintenance of the SRD.")

3.3.2 Review of Hazards Assessment

Requirements

DOE/RL-96-0003 states that the approval of the Contractor's recommended set of radiological, nuclear, and process safety standards and requirements will be issued upon determination by the RO that: "…3) The hazards associated with the proposed facility and its operation are appropriately assessed." DOE/RL-96-0003, Section 4.1.2, "Contractor Input," states: "The Standards Approval submittal package shall consist of the following documentation:…3) The hazards assessment used to facilitate the selection of the standards."

Concept of the DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors, DOE/RL-96-0005, Section 1.0, “Concept,” states that consistent with applicable laws and legal requirements, the Contractor is required to tailor the exercise of its responsibility for:

- Achieving adequate safety
- Complying with applicable laws and legal requirements
- Conforming to top-level standards and principles stipulated by the DOE for the specific hazards.

<u>Review Methodology</u>

The evaluation of the Contractor’s hazards assessment of the process and facility and its proposed operation assessed the information provided in the BNSL HAR for the following attributes from DOE/RL-97-08:

- Methodology: The Contractor’s hazards assessment approach includes methodology, selection criteria for participants, and justification for the selection of the approach.
- Comprehensiveness: The Contractor’s hazards assessment for planned waste processing activities is comprehensive, addressing all of its planned activities and associated postulated events throughout the life cycle (pre-operational testing, operational modes, deactivation, etc.).
- Hazards characterization: The Contractor’s hazards assessment results permit risk-informed judgements to be made on the need for and importance of hazards controls. Furthermore, these same results should address the consequences to the Contractor’s facility workers, Hanford Site workers, the public, and environmental pathways.
- Assessment scope: The Contractor’s hazards assessment approach identifies and characterizes a broad set of hazards, including radiological, nuclear, toxicological, explosion, fire, falling objects, electrical, etc., that could potentially harm workers (facility and/or Site) or the public directly or indirectly through the initiation of hazardous events and/or damage to hazard control features.
- Control strategy facilitation: The hazards assessment provides sufficient detail to enable the use of a graded approach in the formulation of effective and efficient control strategies for each identified hazard. The hazards assessment results facilitate the selection of effective and efficient hazard control strategies through tailoring consistent with risk management approaches and the degree to which this is accomplished.
- Assessment results: The Contractor’s hazards assessment includes results showing the distribution of hazards in the facility for various operational states, the distribution of identified hazardous events by severity and hazard type, and the categories of hazards

that require differing levels of controls because of their risk implications. The following are considerations:

– The degree to which the hazard assessment results for the process element are consistent with the overall results

– The degree to which the hazards identified and characterized for the process element are consistent with those for other similar process elements

– The degree of consistency with results from other similar hazard assessments such as the Defense Waste Processing Facility Final Safety Analysis Report (DWPF FSAR), TWRS Draft Safety Analysis Report (SAR), West Valley Demonstration Project (WVDP) SAR, and Los Alamos National Laboratories (LANL) Preliminary Hazards Analysis (PHA) for Privatization (e.g., completeness and technical reasonableness of types of hazards, their likelihood, their consequences, and their risk binning)

– The reasonableness of the defined events that deliver hazards to various receptors

– The reasonableness of the rationale presented by the Contractor for the qualitative likelihood and consequences of events

– The reasonableness of the treatment of external events

– The reasonableness of the treatment of potential interactions among process elements

- Assessment bases: The Contractor's basis for the assessment and characterization of each hazard, as applicable, consists of hazardous material inventories at risk; release mechanisms (e.g., energy sources); material transportability; transport paths and assumed transport mechanisms; assumed barriers to delivery of the hazard to a designated receptor; health impact considerations used (e.g., dose levels, toxicity of chemicals, etc.); assumed locations of receptors; and assumed prevention/mitigation features or measures, etc.

Evaluation

3.3.2.1 Hazards Analysis Methodology

The reviewers evaluated the Contractor's hazards assessment approach documented in HAR, Chapter 3.0, "Hazard Analysis Methodology," for the methodology, selection criteria for participants, and justification for the selection of the approach.

The HAR describes how BNFL selected the hazard analysis methodology based on BNFL expertise in performing similar studies for nuclear chemical plants and the need to be consistent with AIChE guidelines, Draft NUREG 1530, and 29 CFR 1910. The HAR, Section 3.2, "Selection of a Hazard Evaluation Methodology," describes in detail how BNFL chose the "BNFL Process Hazard Analysis (PHA)" process as the methodology for the hazard analysis of the TWRS-P conceptual process design. Factors taken into consideration by BNFL in selecting a hazard analysis methodology were (1) the motivation for the study, (2) the type of results needed, (3) the type of information available to perform the study, (4) the characteristics of the analysis problem, (5) the perceived risk associated with the subject process or activity, and (6) the resource availability and analyst/management preference. The BNFL PHA process for hazard analysis is an analytical method commonly known as the "What-if" method, supplemented with a checklist developed by BNFL.

The HAR does not provide criteria for the personnel who conducted the hazards assessment but Section 3.2.6, "Resource Availability and Analysis/Management Preference," states that "the hazard evaluation meeting took place in conjunction with the design teams at BNFL in the UK, and Duratek, where a suitable cross-section of disciplines was available. The hazard evaluation team leaders and many of the participants in the hazard evaluation study are most familiar with the technique that has been used by BNFL for its facilities." The HAR, Chapter 5, "Hazard Analysis by Process Step," identifies the hazard analysis team members and their technical fields for each module of the process that was examined.

The Contractor's hazards assessment approach identifies and characterizes a broad set of hazards, including radiological, nuclear, toxicological, explosion, fire, falling objects, electrical, etc., which could potentially harm workers (facility and/or Site) or the public, directly or indirectly, through the initiation of hazardous events and/or damage to hazard control features. The Contractor's statements of the potential accident scenarios are naturally broad at the present level of process development (conceptual design), but they are reasonable. The HAR describes BNFL's decision to first identify the hazards present, and to postulate potential accidents, engineered features, and possible design modifications for a particular portion (module) of the TWRS-P process before estimating accident frequencies and consequence ranks.

The estimates of accident frequencies/consequences pairs ("risk") at this early stage of process design are qualitative, and rely on the "engineering judgement" of qualified BNFL technical personnel. BNFL chose to qualitatively estimate the harmful consequences of postulated accidents after taking credit for controls (safeguards), except where, in the judgement of the hazard analysts, the protection afforded by the proposed controls would be nullified by the mechanics of the accident. This is reflected in BNFL's response to Question 13 concerning the determination of consequence rankings for potential accidents. Thus, accident consequences shown in the fault schedules in the HAR are generally for mitigated accidents. For example, the offsite consequences to the public from an accidental release of radioactive material in a cell were estimated by taking credit for high-efficiency particulate air (HEPA) filters in the cell ventilation system. In contrast, for releases of radioactivity from a vessel resulting from an energetic event, (e.g., explosion) BNFL's hazard analysis teams estimated more severe consequences due to uncertainties. The teams discounted the mitigating features (e.g., the HEPA filters) because it is recognized that the accident could also damage the HEPA filters.

The level of confidence in the accuracy of these estimates of frequency and consequence of potential accidents is sufficient to permit identification of suites of potential control strategies for preventing or mitigating accidents. However, it is insufficient to support the identification of specific control devices or systems for individual hazards. Further refinement of process design to the point where hazard source terms can be established should permit the quantitative estimation of unmitigated accident consequences to workers and the public. Process design development (e.g., to the stage where process and instrumentation drawings can be prepared and reviewed) will permit postulated accidents to be defined with more specificity. This enhanced understanding of potential accident initiators resulting from examination of the more detailed design should then provide a firmer basis for potential accident frequency binning. The increased confidence in the level of risk (frequencies/consequences pairs) posed by the postulated unmitigated accidents will allow a selection of specific control strategies for individual hazards tailored to the risks for a more comprehensive set of potential accidents.

The Contractor committed to providing additional descriptive information to support a more extensive hazards assessment as the design matures (BNFL SRD, Vol. I, Section 3.6, "Action Items"). The ISAR will contain preliminary identification of suites of controls for significant hazards commensurate with the concept design detail (refer to the BNFL presentation on October 23, 1997 [97-RU-B-071]).

3.3.2.2 Analysis Of Process Hazards

3.3.2.2.1 Waste Receipt

The hazard analyses for the LAW and HLW waste receipt processes are included in HAR Sections 5.2.1, "LAW Feed Receipt" and 5.2.4, "HLW Feed Receipt and Pretreatment System." The fault schedules for the LAW waste receipt process include a broad spectrum of accidents including: tank failures, tank support system (ventilation, electric power) failures, and failures in the waste transfer system from the DST to the LAW feed receipt tanks. HEPA filter fires and seismically induced transfer line failures are identified as high-consequence accidents.

Question 180 concerns the potential accumulation of radiolytically generated flammable gases in tank head spaces. The BNFL HAR and the Contractor's response to Question 180 reference a BNFL report on hydrogen generation in TWRS-P tanks that was not provided as part of the SA Package submittal. The Contractor's supplemental response to Question 180 states that BNFL intends to design the tank vent systems to eliminate the possibility for hydrogen accumulation. The Contractor committed to continued safety review (of flammable gas generation in the process) as the design matures.

Question 186 requested an explanation for the Design Class 1 SSC designation for the postulated accident involving seismic failure of the HLW feed receipt tanks (see the BNFL SRD, Vol. I, Table 3-1. The Contractor's response provided an explanation that the LAW/HLW tank failure scenario, which assumed no mitigative or protective features, was examined to determine the hazard potential of the facility: "Although catastrophic vessel failure and loss of all protection features, (e.g., cell shielding, confinement passive features) is not considered credible (and therefore did not appear per se in the HAR), it serves as a bounding case for loss of confinement events (numerous references in the HAR)." The RU's disposition of this response was that it was acceptable because additional information had been provided to explain why the feed receipt tanks should be afforded DC-1 protection, but that "it remains unclear why the feed receipt tanks alone should be afforded DC-I protection…"

3.3.2.2.2 LAW Feed Evaporation and Solids Removal

The reviewers examined the HAR and BNFL correspondence 5193-97-0511, "Proposed Revision to Hazard Analysis Report Chapter 6.0," dated October 16, 1997; and BNFL conceptual design PFDs in BNFL K0104_REP_002_PRC, *TWRS Hanford Basis of Design (LAW and HLW)*, September 14, 1997.

Identified hazards are presented in HAR Sections 5.2.2, "LAW Feed Receipt Evaporator" and 5.2.3, "Entrained Solids Removal System," which in turn present fault schedules for the LAW feed evaporator and ultrafiltration solids removal processes. Appendix A, "Maintenance Fault Schedules," and Appendix B, "Operability Fault Schedules," contain additional hazard analyses.

The adequacy of the scope in identifying and characterizing a broad set of hazards was assessed by review of the fault schedules. The hazards identification and associated potential accidents presented in the fault schedules are appropriate to the conceptual design status of the TWRS-P project and the hazard assessment methodology adopted by the Contractor.

The comprehensiveness of the assessment in addressing planned activities and associated postulated events throughout the life cycle of the LAW feed evaporator and ultrafiltration solids removal systems was evaluated by the reviewers through the review of the fault schedules and reference to the PFDs for additional information, when necessary. The hazards are identified without regard to the life cycle of the process that is acceptable for this stage of design; however, revisions of the hazards analysis should address life cycle effects.

The reviewers evaluated the adequacy of the assessment, specifically, in supporting risk-informed judgements to be made concerning the need for and importance of hazards controls and the assessment of consequences to the Contractor's facility workers, Hanford Site workers, the public, and environmental pathways. The fault schedules project realistic consequences for the postulated accidents. For example, event identifier 2100/0, "External Dose Hazard," identifies "liquid carry-over into vent system," as a possible initiating event; the hazard consequences are "presence of radionuclides in inadequately shielded location;" and "potential for increased dose uptake to Workers/Public." Event identifier 2100/7, "Loss of Containment Hazard," cites "service line rupture" as an event leading to "Active liquor spread into operating areas." Both postulated events are estimated to result in worker exposures above normal levels. Public exposures are not expected to exceed allowable limits.

The Contractor's hazard assessments of LAW feed evaporator and ultrafiltration solids removal subsystems were reviewed for consistency of hazard identification and qualitative consequence conclusions when compared to the overall hazard assessment. The hazard assessments of these subsystems were consistent with the whole of the hazard assessment.

3.3.2.2.3 Cesium and Technetium Removal

The reviewers evaluated the HAR, Rev. 0, Section 5.2.5, "Cesium Removal Using Ion Exchange," which describes the hazards evaluation and fault schedules for cesium removal. Section 5.2.7, "Technetium Removal Using Ion Exchange," describes the hazards evaluation and fault schedules for technetium removal. Additional hazard analyses are contained in Appendix A, "Maintenance Fault Schedules," and Appendix B, "Operability Fault Schedules."

BNFL provided the composition and disciplines of their hazards evaluation teams in HAR Sections 5.2.5.1 and 5.2.7.1. The reviewers determined that the identification of hazards and BNFL's evaluation were comprehensive.

BNFL's cesium team reviewed PFD 2200, DRG. No. O/BE/1614659 in BNFL K0104_REP_002_PRC, *TWRS Hanford Basis of Design (LAW and HLW)*, September 14, 1997, and considered all steps in the process (loading cycle, residual feed removal with caustic, caustic removal with demineralized water, cesium elution with 5.0 M nitric acid, demineralized water rinse, regeneration with 0.5 M and 2.0 M caustic, removal of spent resin and loading of fresh resin). BNFL's technetium team reviewed PFD 2600, DRG. No. O/BE/1614664, and used the results of the hazards evaluation of the cesium ion exchange to focus on differences in the two systems. The fault schedules identify and subjectively assess the consequences of a broad range of events that could potentially harm workers or the public. The Contractor's identification of events that could lead to the following:

1) ignition and fire in the ion-exchange columns;

2) high cesium concentrations downstream from the resins caused by inadvertent cesium breakthrough caused by incorrect operation or inadvertent cesium breakthrough;

3) over-pressurization and possible explosions resulting from resin degradation;

4) leakage; and

5) inadvertent mixing of acid and caustic.

The reviewers determined that BNFL's description of potential accidents is appropriate and provides an acceptable basis for hazards assessment and identification of control strategies.

The estimates of accident frequencies and consequences in this early stage of process design are qualitative and rely on the engineering judgement of qualified BNFL technical personnel.

3.3.2.2.4 Nitric Acid Recovery and Resin Addition

The reviewers evaluated HAR, Rev. 0, Sections 5.2.8, "Cesium and Technetium Nitric Acid Recovery Systems," which describe the hazards evaluation and fault schedules for the cesium/technetium nitric acid recovery system. Sections 5.2.9.1 and 5.2.9.2 describe the hazards evaluation and fault schedules for the fresh resin addition system. Appendix A, "Maintenance Fault Schedules," and Appendix B, "Operability Fault Schedules," contain additional hazard analyses.

BNFL provided the composition and disciplines of the hazards evaluation teams. The reviewers determined that BNFL's hazards identification and hazard evaluations are comprehensive. BNFL's cesium/technetium nitric acid recovery hazards evaluation team reviewed PFD2300, DRG. No. O/BE/1614663 and PFD2700, DRG. No. O/BE/1614667 in BNFL K0104_REP_002_PRC, *TWRS Hanford Basis of Design (LAW and HLW)*, September 14, 1997. The team addressed the following issues: (1) elution and eluant recovery from the ion- exchange columns, (2) eluant concentration by evaporation, and (3) handling of concentrated cesium and technetium solutions following evaporation. BNFL's fresh resin addition hazards evaluation team reviewed the respective PFDs (PFD2800, DRG. No. O/BE/1614669; PFD2900, DRG. No. O/BE/1614670 in BNFL K0104_REP_002_PRC, *TWRS Hanford Basis of Design (LAW and HLW)*, September 14, 1997). The team addressed the following issues: (1) fresh and spent resin transfer operations, (2) separation and disposition of the liquor used in the transfer operations, and (3) disposition of the spent resin by blending with the LAW melter feed.

The fault schedules identify and subjectively assess the public and worker consequences of a broad range of events that could potentially harm workers or the public. The Contractor identifies several potential accidents in the cesium/technetium nitric acid recovery system that could lead to the following:

1) misrouting of the ion-exchange eluants and column washing solutions;

2) over-pressurization and explosive reactions in the evaporator or the concentrate storage tank (V 2710);

3) leakage;

4) fire from ignition of combustibles in the process cells;

5) loss of condenser and V 2710 cooling water supply, leading to acid gases and cesium/technetium volatilization into the vessel vent system; and

6) seismic damage to tank V2710.

The reviewers deemed the Contractor's description of potential accidents to be appropriate and to provide an acceptable basis for hazards assessment and identification of suites of potential control strategies (safeguards).

Question 180 concerns the potential accumulation of radiolytically generated flammable gases in tank head spaces. The HAR and the Contractor's response to Question 180 reference a BNFL report on hydrogen generation in TWRS-P tanks. The Contractor's supplemental response to Question 180 states that BNFL intends to design the tank vent systems to eliminate the possibility for hydrogen accumulation. The Contractor commits to continued safety review (of flammable gas generation in the process) as the design matures.

The Contractor identifies several potential accidents in the fresh resin addition/removal system that could lead to: (1) leakage, for example, due to erosion in the hydrocyclone used to separate resin from the flush liquor; (2) breakthrough of cesium or technetium due to possible use of the wrong ion-exchange materials; (3) over-pressurization due to valve misalignment that results in nitric acid reaction with the SL-644 resin; (4) fire due to energetic exothermic reaction between ion-exchange resin and nitric acid; (5) leakage and spills; and (6) worker exposure due to shine (direct line-of-sight radiation transport) through empty pipework. The reviewers deemed the Contractor's description of potential accidents to be appropriate and to provide an acceptable basis for hazards assessment and identification of suites of potential control strategies (safeguards).

3.3.2.2.5 Cesium Recovery as a Solid

The reviewers evaluated the Contractor's descriptions of the hazards evaluation and fault schedules for the LAW-only process related to recovery of cesium as a dry solid. The descriptions are contained in HAR, Section 5.2.6.1, "Cesium Recovery as a Solid." Appendix A, "Maintenance Fault Schedules," and Appendix B, "Operability Fault Schedules," contain additional hazard analyses.

BNFL provided the composition and disciplines of their hazards evaluation teams. The reviewers found that BNFL's hazards evaluations are comprehensive. BNFL's hazards evaluation team reviewed PFD 2400, DRG. No. O/BE/1614662 in BNFL K0104_REP_002_PRC, *TWRS Hanford Basis of Design (LAW and HLW)*, September 14, 1997, and specifically considered the neutralization of cesium concentrate, cesium loading onto CST ion-exchange media, and drying of the cesium-loaded CST and its encapsulation in a sealed container. The Contractor identifies several events that could lead to (1) dispersion of the dried CST powder by dropped loads, (2) over-pressurization and explosions in the sealed canisters due to accumulation of radiolytic hydrogen from residual water left in the CST after drying, and (3) overflow of process liquor into the vessel vent system. The reviewers deemed the Contractor's description of these events to be appropriate and to provide an acceptable basis for hazards assessment and identification of suites of potential control strategies.

Question 32 addressed the potential accidents associated with radiolytically generated hydrogen in the stored cesium canisters, and the assumption that the CST drying step will remove the free and bound water that is a potential source of radiolytic hydrogen. In its supplemental response to Question 32, the Contractor states that the hazardous situation is "ineffective drying" of the CST after cesium loading: "The information that bound water can only be driven off at elevated temperatures (around 300 °C) will be used in ensuring that the drying process will result in the removal of both unbound and bound water, thus removing the potential for in situ radiolytic gas generation during storage. Preliminary discussions with the vendors have indicated that for similar material, bound water does not give rise to radiolytic gas generation. This conclusion will be pursued during development work with CST to ensure its validity." The Contractor's supplemental response was determined to be acceptable by the reviewers.

3.3.2.2.6 LAW Melter Feed Evaporation

This assessment was conducted through examination of HAR, Rev. 0; BNFL correspondence 5193-97-0511, "Proposed Revision to Hazard Analysis Report Chapter 6.0," dated Oct. 16, 1997; and BNFL PFDs in BNFL K0104_REP_002_PRC, *TWRS Hanford Basis of Design (LAW and HLW)*, September 14, 1997.

HAR, Section 5.2.10, "LAW Melter Feed Evaporator," provides fault schedules for the LAW melter feed evaporator process, and Appendices A and B contain additional hazard analyses of the evaporator system in relation to LAW melter feed evaporation.

The adequacy of the scope in identifying and characterizing a broad set of hazards was assessed by review of the fault schedules. The hazards identification and associated potential accidents presented in the fault schedules are appropriate to the conceptual design status of the TWRS-P project and the hazard assessment methodology adopted by the Contractor.

The reviewers evaluated the comprehensiveness of the assessment in addressing planned activities and associated postulated events throughout the life cycle of the LAW melter feed evaporator system. This evaluation was accomplished through review of the fault schedules and reference to the PFDs. Because the hazards assessment is insensitive to life cycle, the Contractor did not attempt to identify all initiating events for the postulated accidents.

The fault schedules project realistic consequences for the postulated accidents. For example, event identifier 1614661/115, "Internal Dose Hazard," cites "Activity release to the ventilation system" as a postulated initiating event; the hazard consequence is "Increased Internal Dose to Worker/Public." Event identifier 1614661/129, "Loss of Water Hazard," cites "Loss of cooling ability" as an event leading to "Loss of cooling - water vapor to ventilation system" and "Potential for filter systems to collapse" as consequences. Both events are estimated to result in worker exposures above normal levels. Public exposures are estimated to be below allowable limits in the first case but to exceed allowable limits in the second case. Given the potential for loss of ventilation filtration capability in the second example, the reviewers considered the (qualitatively) estimated potential consequences to be reasonable.

The Contractor's hazard assessment of the melter feed evaporator system was reviewed for consistency of hazard identification, control strategy, and qualitative consequence conclusions when compared to the overall hazard assessment. The hazard assessment of the melter feed evaporator system was found to be consistent with the overall hazard assessment.

3.3.2.2.7 LAW and HLW Glass Melters

The reviewers conducted concurrent reviews of the Contractor's hazard assessment of the LAW and HLW melters. The reviews were performed concurrently because the fault schedules are merged into a single section within the BNFL HAR.

Hazards are presented in HAR Section 5.2.11.2, "LAW Melter System Fault Schedules," presents fault schedules for the LAW and HLW melter systems. Appendices A and B contain additional hazard assessments of the melter systems.

The reviewers evaluated the comprehensiveness of the assessment in addressing planned activities and associated postulated events throughout the life cycle of the melter systems. This evaluation was accomplished through examination of the fault schedules and the PFDs. The hazards are identified only for operational modes of the melter systems. In general, pre-operational (startup) modes and deactivation modes are not discussed in the BNFL HAR. However, the key initiating (high consequence) events for replacing the melters as a "normal" operation are discussed in Section 5.2.11.2 and Appendix B. The reviewers determined this limited hazard assessment to be acceptable for selection of suites of potential hazard controls at the current state of conceptual design for the TWRS-P.

The reviewers evaluated the adequacy of the assessment, specifically, in supporting risk-informed judgements to be made concerning the need for and importance of hazard controls and the assessment of consequences to the Contractor's facility workers, Hanford Site workers, the public, and environmental pathways. The fault schedules provide reasonable and realistic qualitative estimates of accident consequences for the postulated initiating events. The fault schedules present consequences for the worker and the public only.

The reviewers evaluated the adequacy of the scope in identifying and characterizing a broad set of hazards through review of the fault schedules and responses to reviewers' questions, including Questions 21 and 128. The Contractor used a consistent set of hazards or "study areas/keywords" to identify hazards and potential accidents (or "hazardous situations") in the LAW and HLW melter process elements. Additional initiating events were identified during the comment cycle for the HAR. The fault schedules were amended by the Contractor to include additional consideration for melter pressurization.

In response to Question 128 concerning disposition of spent ion-exchange resins in the melters, BNFL stated that it proposed to feed spent resins to the LAW melter for both processing options (LAW-only and HLW/LAW). BNFL's response indicated that 1 metric ton (MT)/year of resin would be disposed of in this manner. Because the process feed to the LAW melter is about 30

MT/day, the mass of resin per melter batch is negligible by comparison. "No major process perturbations are expected as a result of the small contribution that spent resins will make to the overall LAW melter feed. Nevertheless, potential perturbations and the need to consider their consequences have been recognized in the need for test work. This test work is included in the BNFL (process development) program." The actions identified by the BNFL hazards evaluation team included the directive that the testwork "determine [the] control method for resin to melter or melter feed system. The concern is too much resin or water being fed to the melter at any time." All parts of the Contractor's response were accepted by the reviewers.

The Contractor's hazard assessment results for the melter systems were reviewed for consistency of hazard identification, control strategy, and qualitative consequence conclusions when compared to the overall hazard assessment. The hazard assessment of the melter systems is consistent with the hazard assessment of the other process elements. Also, the qualitative frequencies and consequences are reasonable for this (conceptual) stage of design. Concerns that low consequence ratings for potential accidents might result in the initiating events being eliminated from the quantitative assessment performed later in the project were discussed in meetings with the Contractor. The Contractor stated that all initiating events (even low consequence events) will be reconsidered during the quantitative assessment. This commitment by the Contractor was considered acceptable to the reviewers.

The Contractor's assessment bases were reviewed for adequacy. Major radionuclide sources were identified in HAR Chapter 4, "Hazard Identification." In response to Question 21 concerning inventories of cesium-137 (^{137}Cs), strontium-90 (^{90}Sr), and technetium-99 (^{99}Tc) as shown in the BNFL HAR, Table 4.1, BNFL provided a revised table (Table 4.1 in Rev. 1 of the BNFL HAR) as Attachment-Question 21 to BNFL's Response to RU Disposition, correspondence 5193-97-0554. The Contractor's estimates of the high-level melter radionuclide content were increased from 14,000, 4,000, and 10 TBq to 70,000, 30,000, and 1,200 TBq of ^{137}Cs, ^{90}Sr, and ^{99}Tc, respectively. The Contractor's qualitative estimates of accident consequences for melter system accidents, evaluated in the BNFL HAR, were unaffected; however, quantitative source terms for each initiating event were not identified. The consequences qualitatively assumed in the fault schedules were difficult to assess without identification of approximate source terms for the major initiating events. Thus, this subject was discussed with the Contractor. During meetings with RU reviewers, BNFL stated that expert judgement was the current basis for the potential accident consequences and that the consequences would not be estimated quantitatively until later in the project. These quantitative values are necessary to determine actual impact to public safety. The RU will assess these values during the design segment of Part B, Phase 1.

3.3.2.2.8 Vitrification Offgas Treatment

The reviewers examined the HAR, BNFL correspondence 5193-97-0511, "Proposed Revision to Hazard Analysis Report Chapter 6.0," dated Oct. 16, 1997; BNFL's conceptual design PFDs; and the resolution of questions developed during the review.

Identified hazards are presented in HAR Section 5.2.12, "LAW Vitrification Offgas Treatment and Emergency Offgas Systems," which provides fault schedules for the LAW and emergency offgas treatment processes. Section 5.2.14, "HLW Vitrification Offgas Treatment System," provides fault schedules for the HLW offgas treatment process. Appendixes A and B contain additional hazard analyses of the vitrification offgas treatment systems.

The reviewers evaluated the comprehensiveness of the assessment in addressing planned activities and associated postulated events throughout the life cycle of the offgas treatment systems. This review was accomplished through examination of the fault schedules and the PFDs. The hazards are identified only for operational modes of the vitrification offgas treatment system. The reviewers determined the limited hazard assessment to be acceptable for selection of potential hazard controls at the current state of conceptual design for the TWRS-P.

The reviewers evaluated the adequacy of the assessment, specifically, in supporting risk-informed judgements to be made concerning the need for and importance of hazards controls and the assessment of consequences to the Contractor's facility workers, Hanford Site workers, the public, and environmental pathways. The fault schedules provide reasonable and realistic qualitative estimates of accident consequences for the postulated accidents. Because of the airborne or gaseous nature of the offgas process stream, the number of potential hazards with more serious consequences to the worker, co-located worker, and the public will be greater than for the liquid process operations. Twenty-nine of the fifty-three event identifier groups contain postulated events that are estimated to result in worker and/or public consequences exceeding allowable limits. For example, event identifier 1614672/239, "Explosion/Overpressure Hazard," for the LAW offgas treatment system postulates "explosion due to carryover of ammonium nitrate" as an initiating event. The hazard consequences for this event are: "Potential for loss of containment of hazardous materials and/or activity from cell, and potential for activity release from explosion." With a consequence rating of three for both the public and the worker, dose rates are estimated to exceed 5 mrem/h in large parts of the operating areas with unrestricted worker access. The worker and public consequence rankings for the postulated accidents in the offgas treatment systems are appropriate for identifying suites of potential hazard controls.

The adequacy of the scope in identifying and characterizing a broad set of hazards was determined by review of the fault schedules and responses to reviewers' questions. The hazards and potential accidents identified in the fault schedules, and the qualitatively estimated consequences, are appropriate for the conceptual state of TWRS-P design and the hazard analysis approach adopted by the Contractor.

Additional potential accidents were identified by the reviewers for the NO_x selective catalytic reduction subsystem and HEPA filter. Question 27 asked whether alternative methods for removal of NO_x from the melter offgas stream had been considered by the Contractor as possible process options, to avoid consumption and storage of liquid ammonia, with the attendant risks of ammonia fires, energetic ammonium nitrate decompositions, and discharges of ammonia. BNFL indicated its belief that selective catalytic reduction with anhydrous ammonia to convert NO_x to nitrogen gas (N_2) is a safe, proven technology. Additionally, the Contractor stated that the process team also investigated scrubbing technologies and selective non-catalytic reduction to remove NO_x from the offgas.

The Contractor's hazard assessments of offgas treatment subsystems were reviewed for consistency of hazard identification, control strategy, and qualitative consequence conclusions when compared to the overall hazard assessment. The hazard assessment of the offgas treatment subsystems was consistent with the overall hazard assessment.

3.3.2.2.9 Container Decontamination

The LAW/HLW container decontamination hazard analysis is found in HAR Section 5.2.16, "LAW/HLW Container Decontamination System." The fault schedules for the LAW/HLW container decontamination process address a comprehensive spectrum of potential accidents including washing operation errors, ultra-high pressure piping failures, and ventilation and other support system failures. The postulated events with the highest consequence were failures of the ultra-high pressure water system, resulting in facility worker injury (these events are highlighted in HAR Section 6.1.5, "Worker Safety Related Event Involving Ultrahigh-Pressure Water." The worker and public consequence rankings for the postulated accidents in the LAW/HLW container decontamination system are appropriate for identifying suites of potential hazard controls.

3.3.2.2.10 Support Systems

The results of the hazard assessments for the support systems are presented in the fault schedules in the HAR, and were evaluated by the reviewers. The worker and public consequence rankings for the postulated accidents in the support systems are appropriate for identifying suites of potential hazard controls.

(a) LAW Vitrification Offgas Treatment and Emergency Offgas System

The LAW Vitrification Offgas Treatment and Emergency Offgas System fault schedule is presented in the HAR, Section 5.2.12.2. Postulated accidents include corrosion and erosion of the equipment, permitting leakage of offgas; closure of duct damper failing, causing melter over-pressurization and leakage of offgas; LAW melter over- pressurization (e.g., from a radiolytic hydrogen/air explosion), resulting in increased dose uptake by workers; failure of filter system, causing increased dose uptake by workers or public; ignition and fire of paper cartridge in HEPA filter, causing increased stack discharges; failure of offgas scrubber, causing increased stack discharges and increased dose uptake by the public; and loss of power or air, causing loss of effectiveness of the offgas filter.

(b) Secondary Offgas Treatment System

The Secondary Offgas Treatment System fault schedule is presented in the HAR, Section 5.2.15.2, "LAW/HLW Secondary Offgas Treatment System Fault Schedules." Postulated accidents include the following:

- failure of ventilation fans causing loss of ventilation of the melters,
- over-pressurization of the high-efficiency mist eliminator (HEME) leading to loss of containment,
- hydrogen fire in offgas system causing an electrical fire,
- iodine generation causing increased dose to workers and the public,
- failure of electrical power supply causing an HEPA filter collapse due to entry of water, and

- loss of chilled or process water to the scrubber causing delay in refilling seal pots with increased dose uptake by workers and the public.

(c) Plant Waste Management System

The plant waste management system handles process condensate, steam condensate, cesium and technetium ion-exchange waste streams, LAW offgas treatment quench water returns and backwashes from LAW melter quench offgas filters, LAW container decontamination washings, HLW vitrification offgas treatment waste streams, HLW container decontamination washings, drains from active areas, drains from nonactive areas, and effluent disposal from the nonactive effluent tank. The fault schedules are presented in the HAR, Section 5.2.17.

The types of accidents featured in the fault schedule encompass the following:

- corrosion/leakage;
- backup of waste in lines to the Effluent Treatment Facility and to the Treated Effluent Treatment Facility;
- dropped loads (e.g., canisters) and impacts; explosions and over-pressurizations;
- misrouted contaminated condensate;
- extreme weather including high rainfall,
- flooding and snow, and low temperatures;
- fires caused by maintenance activities and diesel fuel;
- loss of compressed air for instruments;
- loss of containment caused by overflow;
- loss of electric power causing uncontrolled flows into vessels, with unwanted interactions;
- loss of caustic supply causing increased radioactive iodine releases to the secondary offgas system because acid liquor is not neutralized;
- occupational safety hazards (e.g., high temperatures/burns);
- compromise of vessel shielding (e.g., incorrect operation of gamma gate);
- generation of gases in active tanks causing increased emissions of radioactive iodine from the stack;
- unauthorized entry into transport flask transit tunnel; and toxic vehicle fumes in flask transit tunnel.

The potential accidents involving fires of diesel fuel, dropped loads, and incorrect operation of gamma gates are identified in HAR, Table 6-1, as events that were assigned worker consequence categories greater than 2 (i.e., serious or major consequences) during the consequence ranking of BNFL. (The Contractor revised Table 6-1 to address this concern and resubmitted it to the RU on October 16, 1997.)

(d) Outcell Process Reagents System

The Outcell Process Reagents System fault schedule is presented in the HAR, Section 5.2.18.2, “Process Reagents Fault Schedule.” The types of accidents considered include incorrect feed or misrouting of chemicals; loss of containment caused by dropped loads; external dose hazards caused by cross-contamination from active areas; freezing of bulk caustic storage tank; mixing of incompatible reagents, delivery of wrong chemicals; loss of utilities (power, instrument air, and cooling water); and highly exothermic reactions. This last event is listed in the HAR, Table 6-1, as an event that was assigned a worker consequence category greater than 2 (i.e., serious or major consequences) during the consequence ranking of BNFL. (The Contractor submitted a Rev. 1 version of HAR, Table 6-1, to the RU on Oct. 16, 1997.)

(e) Boiler Water Heat Recovery System

The Boiler Water Heat Recovery System fault schedule is presented in HAR, Section 5.2.19.2, “Boiler Water Heat Recovery System Fault Schedule.” The types of accidents considered include loss of containment caused by water hammer, adverse chemical reactions, and corrosion of feed lines with the potential for worker injury from spills of extremely hot water. This last event, assigned a worker consequence category greater than 2 (i.e., serious or major consequences) during the consequence ranking of BNFL, is listed in the HAR, Table 6-1. (The Contractor submitted a Rev. 1 version of HAR, Table 6-1, to the RU on October 16, 1997.)

(f) Mechanical Handling System

The Mechanical Handling System (LAW Vitrification Line Product Handling) fault schedule is presented in the HAR, Section 5.2.20.2, “Mechanical Handling System Fault Schedule.” The types of accidents considered include shinepath from containers to workers; loss of containment caused by corrosion and erosion or gas buildup inside containers; dropped containers; fires (e.g., of cabling) caused by molten glass; failure to decontaminate filled containers; loss of utilities (e.g., air and electric power); and loss of welding gas causing incomplete container welds.

(g) HVAC Systems

The Heating, Ventilating, and Air Conditioning (HVAC) Systems fault schedule is presented in the HAR, Section 5.2.21.2. The types of accidents considered include contamination of ductwork and filters with the potential for increased uptake to workers and the public; dropped loads/impacts resulting in spread of contamination around hot cells or cave; pressurization of cells caused by malfunctioning of the vent system with the potential for an explosion; extreme temperatures caused by brush fires compromising the ventilation system; sand storms; fires in filters and inside the ventilated areas causing spread of contamination to operating areas; breakthrough of filters; loss of containment (e.g., caused by faults at the filter crushing machines and breaches of ductwork); loss of utilities causing high temperatures in cells with loss of structural integrity of the cells; and external dose hazard from plate-out of radioactive dust in ductwork. Fire in filters, an event assigned a public consequence category greater than 2 (i.e., serious or major consequences) during the consequence ranking of BNFL, is listed in the HAR, Table 6-3. (The Contractor submitted a Rev. 1 version of the BNFL HAR, Table 6-3, to the RU on October 16, 1997.)

3.3.2.3 Analysis Of Facility Hazards

3.3.2.3.1 Radioactive Waste Treatment Building

A description of the hazards evaluation for the waste processing and vitrification operations to be conducted in the Radioactive Waste Treatment Building is provided in HAR, Chapter 5.

The reviewers performed a comprehensive assessment of the process hazards by subdividing the overall process into a number of “process steps” for which the hazards were evaluated to identify the potential consequences to workers and the public. Hazards other than those associated with the process were not identified.

3.3.2.3.2 Immobilized Waste Container Shipping Building

The BNFL SA Package does not include an assessment of the hazards in the Immobilized Waste Container Shipping Building. As described earlier in Section 3.3.2 of this Evaluation Report, the hazards are associated with the immobilized waste container transfer process operations. Because these hazards are expected to be relatively minor, and any postulated accident scenarios depend on the details of the equipment design and operations involved, the reviewers consider that the omission of a hazards assessment for the Immobilized Waste Container Shipping Building is acceptable. Acceptability is contingent on the condition that the Contractor assess the hazards for the Immobilized Waste Container Shipping Building in future updates of the HAR.

3.3.2.3.3 Wet Chemical Storage Building

The HAR does not contain a hazard analysis for the Wet Chemical Storage Building. Dry and liquid “cold” chemicals stored in the Wet Chemical Storage Building are identified in HAR, Section 2.2.3, “Wet Chemical Storage Building,” and in Table 4-2. Data on the hazardous characteristics of each chemical are provided in Table 4-3. The data sources for the potential chemical interactions presented in Table 4-4 are contained in Section 4.2, “Chemical Interactions.”

The Contractor proposes to store 34 MT of liquid anhydrous ammonia in the Wet Chemical Storage Building. At 21 °C (70 °F), the vapor pressure of liquid anhydrous ammonia is ~6 bar. The anhydrous ammonia is a significant hazard in the TWRS-P facility. In response to Question 34 concerning the lack of a hazard analysis in the SA Package for bulk chemical storage, the Contractor responded that “because the level of design for bulk chemical storage (outcell) for Part A design was not sufficiently developed to support the PHA study, a safety review was conducted to approved BNFL procedures, which examined the schematics submitted on (cold) bulk chemical storage.” The Contractor’s response to Question 34 states that the schematics and the system design documents were used as basic data, with facility layout drawings used as supporting data. Each of the "cold" chemical systems was reviewed, hazards identified, and recommendations given to the designers for further design development work. These recommendations were not control strategies, but rather precursors to aid the designer in ensuring that suitable hazard control was being built into the design. For example, a potential hazardous situation involving a loss of concentrated nitric acid was identified; the recommendation in the safety review was that the bermed (i.e., "diked") area within which the nitric acid storage vessel is situated must be acid resistant (i.e., the design was to incorporate suitable acid resistant areas). Major hazards/hazardous situations identified include: spillage/loss of containment, toxic fumes, corrosion (caustic/acidic/NO_x), effluent disposal (incompatibility), chemical reaction (strong acid/caustic/ammonia) with a fire/explosion risk, manual handling, and chemical reactions occurring due to the wrong reagent in the wrong vessel.

The Contractor committed to a more detailed safety assessment of these systems during design development in Part B. The reviewers found the Contractor's response to the question to be acceptable. However, the Contractor provided a supplemental response to Question 34 indicating that the HAR will be revised to include a note regarding the existence of the bulk (cold) chemical safety study and the associated major conclusions.

3.3.2.3.4 Glass Formers Storage Building

The HAR does not contain a hazard analysis of the Glass Formers Storage Building. The dry bulk chemicals stored in the building are listed in Section 2.2.4, "Glass Formers Storage Building." Data on the hazardous characteristics of the chemicals are provided in Table 4-3. The data sources for the potential chemical interactions presented in Table 4-4 are provided in Section 4.2, "Chemical Interactions."

Question 34 concerning the lack of a hazard analysis in the SA Package for bulk chemical storage resulted in the following response from the Contractor:

> "Because the level of design for bulk chemical storage (outcell) for Part A design was not sufficiently developed to support the PHA study, a safety review was conducted to approved BNFL procedures, which examined the schematics submitted on (cold) bulk chemical storage."

As indicated in the Contractor's response, the schematics and the system design documents were used as basic data, with facility layout drawings used as supporting data. Each of the "cold" chemical systems was reviewed, hazards identified, and recommendations given to the designers for further design development work. These recommendations were not control strategies, but rather precursors to aid the designer in ensuring that suitable hazard control was being built into the design. For example, a potential hazardous situation involving loss of concentrated nitric acid was identified; the recommendation in the safety review was that the bermed (i.e., "diked") area within which the nitric acid storage vessel is situated must be acid resistant (i.e., the design was to incorporate suitable acid resistant areas). Major hazards/hazardous situations identified include spillage/loss of containment, toxic fumes, corrosion (caustic/acidic/NO_x), effluent disposal (incompatibility), chemical reaction (strong acid/caustic/ammonia) with a fire/explosion risk, manual handling, and chemical reaction due to the wrong reagent in the wrong vessel.

The Contractor committed to provide a more detailed safety assessment of these systems during design development in Part B. The reviewers found the Contractor's response to the question to be acceptable. However, the Contractor provided a supplemental response to Question 34 indicating that the HAR will be revised to include a note regarding the existence of the bulk (cold) chemical safety study and the associated major conclusions.

3.3.2.3.5 Other Buildings

As noted in HAR, Section 2.2.5, “Other Buildings,” the Melter Assembly Building, Empty Container Storage Building, Services Building, and the Administration Building are not included in the hazard evaluation, as they do not contain significant quantities of hazardous materials.

3.3.2.4 Analysis Of Selected Hazards

3.3.2.4.1 Criticality

The HAR, Rev. 0, contains a preliminary assessment of potential criticality accidents. The fault schedules identify potential criticality accidents in the LAW and HLW feed receipt tanks, the LAW Technetium Removal IX columns, the LAW IX column resin, and the HLW melter vessel. Also, the BNFL HAR, Rev. 1, Table 4-1, presents the fissile material content of some of the process vessels. However, the HLW melter feed tanks were neither assessed for potential criticality accidents nor were there fissile material inventories included in Table 4-1. Total fissile material contents and geometries of the various process vessels were not presented. This information is essential for a qualitative evaluation of potential criticality accidents. The level of detail in the criticality hazard assessment is based on the following assumptions: (1) the expectation that fissile material concentrations will be low in the process streams, (2) a detailed criticality evaluation will show that criticality excursions are not credible, and (3) no design features are needed to prevent criticality.

3.3.2.4.2 Fire Protection

The evaluation of the Contractor's control strategies for fire hazards assessed the information in the BNFL submittal with respect to whether 1) the Contractor's hazard assessment approach is comprehensive, 2) the results permit risk-informed judgements to be made on the need for and importance of fire prevention and protection measures, 3) the assessment had sufficient detail to enable the use of a graded approach in the formulation of an effective fire prevention and control strategy, and 4) the treatment of fire risk was reasonable and consistent as compared to similar facilities elsewhere.

The HAR identified a number of fire-related initiating events. However, the reviewers found that the set of events was not comprehensive. For example, internal facility fires as a cause of common failures were not completely evaluated. Additionally, fire events will likely be identified as the design evolves. Nevertheless, the reviewers determined that the HAR identified a sufficient number of events to assess, in general terms, the Contractor's approach to fire hazards assessment and mitigation.

For each event, the Contractor identified the likely cause of the specific fire and the flammable and combustible materials that would contribute to the severity. The evaluation included a determination of the likely consequences of the fire to the safety of the public, workers, and program continuity. BNFL developed and implemented a ranking scheme that permitted a comparison of fire events on the basis of frequency and consequences. This, in turn, enabled greater emphasis to be placed on providing effective fire prevention and protection on those events that had greater adverse impact.

Corresponding to each fire event were a series of fire prevention and protection safeguards (control strategies). Reflecting the multi-faceted defense in depth philosophy, the Contractor has delineated both programmatic (e.g. combustible control procedures) and facility-specific (e.g. manual and automatic fire protection systems) that are intended to mitigate the fire hazards. Because these features are required by both industry standards as well as NRC and DOE fire safety criteria, they are considered reasonable and consistent with fire protection programs at similar facilities.

Therefore, the reviewers concluded BNFL had performed a reasonably comprehensive hazard assessment for fire protection considering the extent of completion of the design. The nature of fire protection to mitigate fire risk is based on a graded approach that reflects the level of risk associated with given fire scenarios. The reviewers concluded the hazards assessment for fire protection was reasonable and consistent with hazards assessments performed on similar facilities at this stage of design.

Conclusions

The reviewers concluded that the Contractor's selection of hazard analysis methodology is carefully described and appropriate for the current level of TWRS-P design. Selection criteria for participants were not presented, but personnel and their technical areas of expertise were identified in HAR, Chapter 3, "Hazard Analysis Methodology."

With respect to process hazards in the Waste Receipt, LAW Feed Evaporator, Cesium and Technetium Removal Ion Exchange, LAW Melter Feed Evaporator, LAW and HLW Glass Melters, and Vitrification Offgas Treatment process areas, the reviewers determined that the Contractor's hazards evaluation is:

- Sufficiently broad in scope to embrace all the potential accident types;
- Adequate for identification of suites of potential hazard controls; and
- Appropriate to the current level of design and to the Contractor's TWRS-P conceptual process design presented in the SA Package.

In the case of the Waste Receipt process area, however, this acceptance is qualified by the expectation that hydrogen generation and potential explosions of flammable gases in process vessels will be examined quantitatively in Part B of the project.

With respect to facility hazards in the Wet Chemical Storage Building and the Glass Formers Storage Building, the reviewers concluded that the Contractor's hazards evaluation, while not undertaken with a level of effort comparable to that employed for the radioactive chemical processing sections of TWRS-P, is adequate to provide designers with clear directions for more detailed design of the buildings and the chemical containment systems inside them. The more detailed safety assessment of these systems during design development, to which BNFL has committed during Part B, is expected to permit closer definition of postulated accidents, and the selection of specific control strategies for individual hazards, tailored to the risks posed to the workers and the public.

With respect to facility hazards in the Melter Assembly Building, Empty Container Storage Building, Services Building, and Administration Building, the reviewers concluded that the absence of significant chemical or radiological inventories within them justifies the lack of process hazard analyses for these buildings in the HAR.

The reviewers concluded that the hazards assessment with respect to criticality is incomplete. BNFL's level of detail in their preliminary assessment of potential criticality excursions in the HAR is acceptable, given the preconception (made in the HAR) that no engineered criticality controls or criticality alarm systems are needed. However, the reviewers found that BNFL failed to provide sufficient additional information (as committed to in SA Package Question 23) in the Initial Safety Assessment Report (ISAR) to support the assumption that no engineered criticality controls or criticality alarms were needed. The ISAR did not provide detailed analysis of accident conditions in the process that might impact criticality safety. Additionally, the ISAR did not justify important assumptions regarding minimum critical concentrations of fissile material in the process stream. The hazard analysis associated with criticality remains open and must be resolved prior to authorization of construction.

3.4 Appropriate Implementation of Stipulated Standards Identification Process

Requirements

DOE/RL-96-0003 requires that the Contractor's SA Package contain "The standards identification process used...;" and that "The set documented in the SRD was generated through the appropriate implementation of the standards process stipulated by DOE in *Process for Establishing a Set of Radiological, Nuclear, and Process Safety Standards and Requirements for TWRS Privatization*, DOE/RL-96-0004, Revision 0." Furthermore, "The Essential Process Steps listed in the first column [of Table 1 in DOE/RL-96-0004] shall be performed by the Contractor to ensure that the process is performed in a manner consistent with DOE's Standards Program."

Review Methodology

The evaluation of the appropriate implementation of the stipulated standards identification process assessed the information provided by BNFL with respect to the seven Essential Process Steps listed in DOE/RL-96-0004. For this part of the review, the reviewers focused on the adequacy of the execution of the process steps, not on the technical adequacy of the results to control hazards, which is the subject of Sections 3.3 and 3.6 of this Evaluation Report. This examination was conducted through review of the material presented in the BNFL SRD and resolution of questions developed during the review.[1]

Evaluation

The initial description of the BNFL standards identification process is provided in the BNFL SRD, Vol. I, Chapter 2, "Process Initiation;" Chapter 3, "SRD Development Process;" and Chapter 4, "Confirmation Process." Supplemental information is provided in BNFL Inc. correspondence 5193-97-0513, (Oct. 23, 1997), and in BNFL Inc. letters 5193-97-0533 (Nov. 11, 1997) and

[1] Regulatory Unit questions 42-69, and 190 were developed to obtain additional information for this portion of the review.

5193-97-0554, (Dec. 8, 1997), responding to the RU's questions. In particular, "Attachment Question 43," to BNFL Inc. letter 5193-97-0554, provided most of the final description of the BNFL standards identification process.

To assess the adequacy of the execution of the seven Essential Process Steps, the reviewers compared the description of the BNFL standards identification process to the Acceptable Approach listed in the third column of Table 1 in DOE/RL-96-0004. The reviewers also considered the attributes provided in RL/REG-97-08, June 26, 1997, Section 7, "Standards Identification Process Review-Seven Essential Steps." Detailed descriptions addressing each of the Essential Process Steps, respectively, are provided in the following paragraphs.

3.4.1.1.1 Essential Process Step 1 - Process Initiation

The reviewers found Step 1 to be adequately executed. BNFL assembled a TWRS-P team based on the knowledge, skills, and professional experience of the individual team members, combined with corporate infrastructures and corporate operational experience. Process initiation includes identifying key personnel supporting development of the BNFL TWRS-P Project. A listing of core personnel and their roles in the development of the SRD is provided in "Attachment Question 43" to BNFL Inc. Letter 5193-97-0554. Personnel qualifications are provided in Attachments A, B, and C to the BNFL SRD, Vol. I and further clarified in BNFL's responses to Question 53. Procedures were prepared or modified to provide a basis for governing the activities involved in the identification of standards. Included in these procedures are company QA procedures, BNFL TWRS-P Project-specific training information, and procedures directly related to the identification of radiological, nuclear, and process safety standards. A listing of the procedures related to development of the standards is provided in "Attachment Question 43" to BNFL Inc. Letter 5193-97-0554. Participation by stakeholders is described in the BNFL SRD, Vol. I, Section 3.7, "Stakeholder Involvement" and further clarified in BNFL's responses to Question 68.

3.4.1.1.2 Essential Process Step 2 - Identification of Work

The reviewers found Step 2 to be adequately executed. BNFL work activity experts (WAEs), identified in "Attachment Question 43" to BNFL Inc. letter 5193-97-0554, defined the overall processes in a Basis of Design (BOD) document. Development of the BOD was performed in accordance with BNFL TWRS-P Procedure E-01-TWRS, "Project Documents, Drawings and Lists Requirements." The BOD was approved by project technical managers for BNFL Engineering Ltd. and BNFL Inc. The BNFL TWRS-P work was further defined in HAR, Section 2.2, "Facility Description;" Section 2.3, "Process Description;" and 5.0, "Hazard Evaluation by Process Step." Additional details of the identified work are provided in preliminary PFDs, preliminary engineering flow diagrams, preliminary ventilation flow diagrams, and preliminary equipment layout drawings.

3.4.1.1.3 Essential Process Step 3 - Hazards Evaluation

The reviewers found Step 3 to be adequately executed. From the preliminary design documents, operational experience of similar facilities, and PHA development that were conducted as part of the BNFL Inc. proposal, BNFL hazards assessment experts (HAEs) evaluated the hazards associated with the waste treatment process steps. A description of the hazard analysis process was provided in HAR, Chapter 3, "Hazard Analysis Methodology." Section 3.2, "Selection of a Hazard Evaluation Methodology," of the HAR described BNFL's selection of a hazard assessment approach. The hazard analysis was conducted in accordance with BNFL Procedure K0104-REP-002-SAF, "Process Hazard Analysis Procedure for TWRS-P." The hazard assessment approach defined in K0104-REP-002-SAF was based on the what-if/checklist method, augmented by categorization of potential hazards according to their consequence and frequency.

BNFL separated the overall preliminary waste treatment process into steps that were each the subject of a hazard evaluation. The primary documents for each evaluation included the preliminary process flow diagrams for the respective step under consideration. Supporting information included documentation from similar BNFL projects, such as the Fully Developed Safety Cases for the Windscale Vitrification Plant, the Enhanced Actinide Removal Plant, and the Site Ion Exchange Plant. Operating occurrence reporting records from the Defense Waste Processing Facility at the Savannah River Site in Aiken, South Carolina, and the West Valley Demonstration Project in West Valley, New York, were also used in BNFL's hazards evaluation.

The HAR identified initiating events, consequences of those events including ranking of worker and public consequences, and potential safeguards to prevent or mitigate the events. The results of the hazard evaluations were tabulated in fault schedules presented in the HAR.

3.4.1.1.4 Essential Process Step 4 - Identification of Standards

The reviewers found Step 4 to be effectively incorporated in BNFL documents; however, BNFL inconsistently executed the process. The BNFL teams selected and justified standards based on the identification of work and the hazards evaluation, as required by this Essential Process Step. Adequate execution of this process step is apparent through the process description contained in SRD, Chapter 3, "SRD Development Process", and in the supplemental information provided in the BNFL Inc. Letters of Oct. 23 (5193-97-0513), Nov. 11 (5193-97-0533), and Dec. 8, 1997 (5193-97-0554) - in particular, "Attachment Question 43" to BNFL Inc. Letter 5193-97-0554. However, in some instances BNFL did not identify adequate subordinate (implementing) standards.

The Requirement Identification Team (RIT) identified and developed BNFL TWRS-P safety criteria, implementing consensus codes and standards, and other standards (including BNFL TWRS-P procedures, policies, and other documents) based on the design information, hazard identification, and the suite of proposed safeguards identified in the BNFL HAR. The RIT members included the Environmental Safety and Health standards experts referred to in the Acceptable Approach listed in the third column of Table 1 in DOE/RL-96-0004. The BNFL standard identification process was conducted in accordance with BNFL procedure ESH-04-TWRS, "Safety Requirements Document Development Procedure."

Design information used in the development of the SRD included process specific activities (e.g., radioactive waste handling, processing, and storage of chemicals) from Essential Process Step 2, "Identification of Work." On the basis of this information, safety criteria were identified and developed to ensure compliance with applicable laws and regulations and conformance to DOE/RL-96-0006. These criteria were then relayed back to the WAEs to ensure that the design of the BNFL TWRS-P facility would meet these requirements. In addition, personnel exposure standards (public and worker) were developed and provided to the HAEs for use in development of the risk guidelines identified in Sections 3.3, "Hazard Analysis Methodology," and 3.4, "Ranking of Hazards," of the HAR. On the basis of the hazards identified in the HAR and associated potential safeguards, safety criteria were identified by the RIT. Implementing codes and standards and other standards were identified by the RIT as required to ensure implementation of the safety criteria. To assist in the development of standards, other relevant sources of performance-based expectations (e.g., NRC regulations and guidance, DOE Directives and Standards, draft regulations) were reviewed; a list of these documents is contained in the SRD, Vol. I, Attachment D, "SRD Development Basis Documents." The BNFL standards identification process steps were employed iteratively to develop the design, refine the hazards evaluation, and identify safety standards. Interactions among the personnel involved in the above activities were facilitated by the process management team.

The reviewers also found that selection of standards based on Essential Process Steps 2 and 3 was demonstrated by the identified linkage of standards to hazards, laws, regulations, or top-level standards and principles. These links were provided in the SRD, Tables 3-1, 3-2, and 3-3, Attachment E, and the supplemental information provided in BNFL Inc. letter 5193-97-0513, Attachments 3 and 4. BNFL letter 5193-97-0513 contained the response to the open issue identified in the RU's acceptance letter for the SA Package (97-RU-0307). The open issue was that BNFL did not initially provide sufficient information in the SA Package for the RU to confirm that the HAR was used to facilitate the selection of standards. BNFL subsequently provided sufficient information in its letter dated Oct. 23, 1997, and in BNFL's responses to Question 190.

Observation: In assessing the hazard control approaches, the reviewers noted that BNFL identified a suite of potential safeguards for many hazards, and that due to the early stage of design, those approaches have not yet been finalized. BNFL indicated that it would continue to review and select engineered features or administrative controls from the potential safeguards and that subsequent changes to the standards set may occur as the design is finalized.

3.4.1.1.5 Essential Process Step 5 - Confirmation of Standards

The reviewers found Step 5 to be adequately executed. BNFL Inc. identified the independent safety review team (ISRT) as the organizational unit primarily responsible for this step. BNFL procedure ESH-01-TWRS, Rev. 1, "Independent Safety Review," describes the ISRT's scope, authority, responsibilities, membership requirements, and identified meeting minutes as quality documents subject to the BNFL records system. The ESH-01-TWRS, Rev. 1, Attachment A-1, "Independent Safety Review Team Charter", and the BNFL SRD, Vol. I, Section 2.3.2, "Requirement Identification Team Credentials," describes team membership requirements in terms of experience, general knowledge, and independence from the material being reviewed, and also describes the method of validation. The BNFL SRD, Vol. I, Attachment C, "Independent Safety Review Team Staffing and Qualifications", identifies the ISRT chairperson and permanent team members, classifies member skills with emphasis on Part A needs, and describes individual educational and professional experience. On an "as needed" basis, qualified temporary ISRT participants were utilized to provide those skills that could not be provided by the permanent team members.

The ISRT confirmation process is described in the BNFL SRD, Vol. I, Section 4.1, "Confirmation Process Description," with additional elaboration on this subject provided in the BNFL response to Question 69. The ISRT verified conformance of the BNFL SRD Development Procedure to the DOE-stipulated standards identification process and confirmed that implementation of the procedure is acceptable. The ISRT reviewed the hazards identified in the PHA and ensured that the SRD contained the appropriate standards. The ISRT verified that applicable laws and regulations as well as "contractual drivers" by periodic reviews of safety documents were identified by the process. The ISRT evaluated the credentials of the RIT subject matter experts.

The ISRT recorded the findings of periodic ISRT reviews. SRD Vol. I, Section 4.2, “Independent Safety Review Team Findings”, describes major comments related to process initiation activities, requirements identification, safety criteria development, and SRD confirmation. Disposition of ISRT findings is described in SRD Vol. I, Section 4.3. Disposition of comments is verified by subsequent ISRT reviews.

Stakeholder involvement is described in SRD, Vol. I, Section 3.7, “Stakeholder Involvement,” and in BNFL’s response to Question 68. Although stakeholder involvement was part of the confirmation process, it was managed by the Contractor Representative and BNFL staff. Stakeholder participation included the Hanford Advisory Board and state and local county health experts.

<u>Observation</u>: On the basis of the BNFL responses to Questions 68 and 69, the reviewers observed that the BNFL confirmation process did not include participation of representatives from other related interests such as the DOE (the customer), the Office of Civilian Radioactive Waste Management, the Hanford Site contractors providing support services, or the local labor interests. The reviewers also observed that the stakeholders reviewed the BNFL SRD Development Procedure and the *Safety Approach to TWRS Privatization* document (BNFL 1997a) rather than the SRD itself. Stakeholder comments were recorded on Document Record forms and dispositioned during the development of safety “deliverables.”

3.4.1.1.6 Essential Process Step 6 - Formal Documentation

The reviewers found that Step 6 was adequately executed. SRD Vol. I, Section 4.1, “Confirmation Process Description,” describes measures to ensure process implementation. Consistent with the Acceptable Approach, the BNFL Procedure ESH-04-TWRS, Rev.0, Section 4.1, “Process Manager,” assigns to the process manager the responsibility for preparing the SRD. Likewise, Section 4.3, “Process Management Team,” assigns to the process management team the responsibility for ensuring the overall implementation of the SRD development process. The process manager’s role in reviewing the draft submittal and the recommendation of the final submittals is not described. However, review (SRD Vol. I, Section 4.1) and recommendation for approval (SRD Vol. I, Section 4.3) are performed by the ISRT. This is not consistent with the Acceptable Approach; however, it was deemed acceptable because it was consistent with the concepts of DOE M 450.1-3, “The Department of Energy Closure Process for Necessary and Sufficient Sets of Standards,” as allowed in DOE/RL-96-0004.

SRD development procedure ESH-04-TWRS, in Section 4.1, “Project Manager,” identifies the project manager as the approval authority of the BNFL SRD. Approval of the SRD by the project manager is not demonstrated in the initial SRD submittal. However, the project manager certifies that the set of radiological, nuclear, and process safety standards in the BNFL SRD, when implemented, will provide adequate safety, comply with all applicable laws and regulations, and conform to the RL-stipulated top-level safety standards and principles (see the SA Package transmittal letter [5193-97-0449-PM]). Recommendation for approval by the ISRT and certification by the project manager (who is also the Contractor representative) implied that approval by the project manager was sought and received. Letter 5193-97-0565 provided the document approval signature sheets for the SA Package documents, and these sheets were subsequently signed by the project manager.

3.4.1.1.7 Essential Process Step 7 - Recommendation by Contractor Representative

The reviewers found that Step 7 was adequately executed. The BNFL contractor Representative provided the necessary certification statement in the notarized SRD transmittal letter (BNFL Inc. 5193-97-0449-PM). The statement reads, in part: "…I certify that the set of radiological, nuclear, and process safety standards in the SRD, when implemented, will provide adequate safety, comply with all applicable laws and regulations, and conform to the DOE/RL-stipulated Top Level Safety Standards and Principles." Additionally, the reviewers found that the Contractor recognized the contractual commitment that was made. The reviewers made this assessment on the basis of the information in the notarized letter, which states: "The SA Package is responsive to the Contractor Input information requirements defined in Section 4.1.2 of Reference 4[2], which states that certification is required regarding specific standards in the SRD."

Conclusions

The reviewers concluded that the Contractor's SA Package contains a description of the BNFL standards identification process that was used, and that the BNFL set of standards documented in the SRD was generated through the appropriate implementation of the standards process stipulated by the DOE. Furthermore, the reviewers concluded that the Essential Process Steps listed in the first column of Table 1 in DOE/RL-96-0004 were generally adequately executed by the Contractor. However, the reviewers noted the following : (1) because of inconsistent implementation of the "Identification of Standards" Essential Process Step some subordinate standards were not adequately identified (2) because of the early stage of design, the selection of engineered features or administrative controls from the potential safeguards identified in the HAR have not been finalized, (3) the BNFL confirmation process does not include participation by non-BNFL interested parties or the stakeholder review of the SRD itself.

3.5 Appropriate Expertise Used for Standards Selection and Confirmation

Requirements

DOE/RL-96-0003 requires that the Contractor's SA Package contain "…the credentials of the participants;" and that "Appropriate expertise was employed in the standards selection and confirmation processes."

Review Methodology

The reviewers evaluated the use of appropriate expertise for standards selection and confirmation, and assessed the information provided by BNFL with respect to the following: (1) whether team staffing requirements, roles, and responsibilities had been identified; and (2) the appropriateness of the credentials of the process management team, the standards identification team, and the

[2] Reference 4 in BNFL Inc. letter 5193-97-0449-PM was DOE/RL-96-0003, *DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors*, Revision 0, dated February 1996.

independent review team. This examination was conducted through review of the material presented in the SRD, and resolution of questions developed during the review.[3]

Evaluation

The initial information concerning the credentials of the participants in the BNFL standards selection and confirmation processes are provided in the following documents: the BNFL SRD, Section 2.3, "SRD Development Team Credentials," together with Attachment A, "SRD Process Management Team Staffing and Qualifications Requirements;" Attachment B, "SRD Requirement Identification Team Staffing and Qualifications Requirements;" and Attachment C, "Independent Safety Review Team Staffing and Qualifications Requirements." Supplemental information provided in response to questions is found in BNFL letters 5193-97-0533 and 5193-97-0554. In particular, "Attachment Question 43" to Letter 5193-97-0554 and BNFL responses to Question 53 provide most of the information concerning the expertise used for standards selection and confirmation.

Information pertaining to credentials and expertise was reviewed. Specifically, the reviewers considered the third bulleted item under the "Acceptable Approach" for "Essential Process Step 1, "Process Initiation" (DOE/RL-96-0004), which states that the "PM prepares implementation plan including team staffing requirements….and the attributes provided in Section 7, "Standards Identification Process Review- Seven Essential Steps" (RL/REG-97-08).

The adequacy of the Requirements Identification Team (RIT) composition as a whole was based on the Independent Safety Review Team's (ISRT) review and approval of the recommended topical areas presented in Attachment B. The fundamental qualification criterion for subject matter experts (SMEs) was a minimum of 5 years experience in the nuclear or process chemical industry relative to a particular area of discipline. The responsible line management assigned SMEs to serve on the RIT. Qualifications of the RIT members were reviewed and verified by the ISRT chairperson. Staffing of the ISRT was conducted in accordance with ESH-01-TWRS, "Independent Safety Review Team." Staffing of the process management team (PMT) was based on the determination by the PMT lead and the Contractor representative as to whether the PMT was capable of performing its specified functions as identified in ESH-04-TWRS.

Conclusions

The reviewers concluded that the Contractor's standards set conforms to the appropriate expertise used for the standards selection and confirmation principle contained in DOE/RL-96-0003. Staffing requirements, roles, and responsibilities of the teams were identified. The credentials of the process management team, the standards identification team, and the independent review team were found appropriate for this standards approval regulatory action.

The reviewers concluded that appropriate expertise was used for BNFL's standards selection and confirmation. The credentials of the process management team, the standards identification team, and the independent review team were provided in SRD, Vol. I, Attachment A, "SRD Process Management Team Staffing and Qualifications Requirements," Attachment B, "SRD Requirement

[3] Regulatory Unit questions 43, 52 - 55, and 69 were developed to obtain additional information for this portion of the review.

Identification Team Staffing and Qualifications Requirements," and Attachment C, "Independent Safety Review Team Staffing and Qualifications Requirements," respectively. BNFL responses to questions, in particular Questions 43 and 53, clarify the information in the attachments.

3.6 Safety Adequacy of SRD

Requirements

DOE/RL-96-0003 requires that the Contractor's SA Package contain "the rationale for the selection of the standards and the adequacy of the set" and that the Contractor's "certification that the set of radiological, nuclear, and process safety standards in the SRD will, when implemented, provide adequate safety, comply with all applicable laws and regulations, and conform to the DOE-stipulated top-level safety standards and principles." Pursuant to DOE/RL-96-0003, the RO must, in order to approve the SRD, make a final determination that the "set [of standards] documented in the SRD will provide adequate safety if properly implemented."

Review Methodology

The information provided by BNFL was assessed to the following attributes: (1) the "adequacy of the hazards control strategies (physical features or human actions selected to provide protection for facility workers, co-located workers, and the public) for the hazards associated with the process element to provide a documented basis utilized in implementing the hazards control," (2) the "adequacy of the standards for implementing the hazards control strategy for the process element being reviewed," (3) the compliance of the standards set with applicable laws and regulations; (4) the conformance of the standards set to the DOE-stipulated top-level safety standards and principles; (5) the adequacy of the standards development process; and (6) the adequacy of safety management processes in assuring that any unanticipated hazards will be identified and that appropriate standards-based controls will be developed for such hazards.

Compliance with these six attributes is sufficient to provide reasonable assurance that the set of standards documented in the SRD will provide adequate safety if properly implemented. The combination of adequate hazard control strategy and the selection of adequate standards to implement the hazard control strategy ensures adequate protection against identified hazards. Compliance of the standards set with applicable laws and regulations, and conformance to the top-level standards and principles, ensure that the standards incorporate those safety measures. This includes safety measures not directly associated with specific hazards and which experience has shown to be necessary for adequate safety. An adequate standards development process (i.e., one that appropriately implements the standards development process stipulated in DOE/RL-96-0004) provides additional assurance that the selected standard set incorporates all standards and requirements necessary to provide adequate protection against identified hazards.

When all these attributes are satisfied, the only element of adequate safety that is not addressed is the assurance that adequate protection will be provided against any unanticipated hazards that might develop. This assurance is provided by the sixth attribute: "the adequacy of the safety management processes in assuring that any unanticipated hazards will be identified and that appropriate standards-based controls will be developed for such hazards." Thus, the combination of a standards set, a standards development process, and the safety management processes that meet these six attributes is considered to be a sufficient basis for the determination that the set of standards documented in the SRD will provide adequate safety if properly implemented.

3.6.1 Adequacy of Hazards Control Strategies

Review of the adequacy of the hazards control strategies was divided into an assessment of the control strategies associated with the process hazards (Section 4.6.1.1, “Process Hazards Control Strategies”) and the control strategies associated with the facility hazards (Section 4.6.1.2, “Facility Hazard Control Strategies”).

3.6.1.1 Process Hazards Control Strategies

Requirements

DOE/RL-96-0003, Section 4.1.2, “Contractor Input,” states: “The Standards Approval submittal package shall consist of the following documentation...4) The hazards control strategy implemented in the design and proposed operations.”

Review Methodology

The reviewers considered the following questions during the evaluation of each hazard control strategy:

- Was the control strategy appropriate and reasonable for the selected safety (protection) function(s) and its characterization (e.g., highly reliable for all operating modes and under accident conditions)?

- Was the control strategy for each hazard (or class of hazards) consistent with, or appropriately different from, strategies used to control similar hazards in similar settings (e.g., the Defense Waste Processing Facility (DWPF) or the West Valley Demonstration Project (WVDP))?

- Did the Contractor designate a reasonable control strategy from a number of strategies, if several control strategies were still under consideration for a given hazard or class of hazards?

Evaluation

3.6.1.1.1 Waste Receipt Process

Sections 5.2.1 and 5.2.4 of the HAR describe the hazard controls for the LAW and HLW waste receipt processes. Appropriate sets of candidate controls are identified for each accident in the safeguards column of the fault schedules. The following control systems or procedures are considered most significant: DST annulus leak detection, backup DST ventilation, independent verification of feed specification, transfer line corrosion monitoring, berming or burying of transfer lines, coaxial pipework with annulus leak detection, and prevention of hydrogen gas buildup. The identified controls in combination with the qualitative consequence and frequency rankings are adequate to permit the selection of appropriate standards.

The reviewers deemed resolution of the review questions regarding the waste receipt hazard controls to be satisfactory. In its response to Question 180, BNFL committed to develop engineered controls to prevent hydrogen accumulation, as the plant design develops. Supplemental information regarding additional controls on a transfer line break was provided in response to

Question 179. The Contractor notes in its supplemental response that the structural integrity of the transfer line will be ensured by specifying design class DC I protection if it is shown in the accident analysis that worker or public exposure standards are exceeded. The reviewers consider this additional information to be acceptable.

3.6.1.1.2 LAW Feed Evaporator and Solids Removal by Ultrafiltration

Specific hazards and proposed control strategies are presented in the HAR. Sections 5.2.2, "LAW Feed Receipt Evaporator," and 5.2.3, "Entrained Solids Removal System," provide fault schedules for the LAW feed evaporator and ultrafiltration solids removal processes. Appendices A and B contain additional hazard analyses.

The Contractor did not attempt to identify every initiating event. The Contractor also did not attempt to explicitly link one or more specific hazard controls to mitigate each initiating event. The Contractor's stated intent was to identify worst-case hazards, hazard consequences, plausible initiating events, and possible safeguards. This is consistent with the hazards review strategy used by the Contractor for this analysis. In general, the proposed safeguards cited as potential safeguards are reasonable and consistent with engineering practices employed at similar facilities. The reviewers concluded that an assessment of the completeness of the control strategies (safeguards) should not be conducted until completion of detailed design and engineering activities.

The primary hazards for the evaporator and ultrafiltration processes are the generation of liquid and aerosol/gaseous discharges due to equipment failure or process upsets (e.g., Event Identifier 2100/0). The control strategy is the application of physical containment and filtration capabilities (i.e., SSCs). Liquid discharges from equipment will be retained by steel-lined concrete cells constructed with sump collection systems. The cell ventilation will be designed to capture airborne contaminants. This is consistent with the hazard control strategy of similar facilities. Short of a catastrophic failure of a subsystem, control strategies for hazards initiated by process upsets, or operator or equipment failure, are not defined at this time. This is acceptable due to the conceptual nature of the design. For example, in Event Identifier 2100/4, Internal Dose Hazard, safeguards are identified as follows: (1) appropriate sizing of the condenser to forestall the potential for this event; (2) high activity in process condensate subject to monitoring and treatment; and (3) the presence of barometric heads on all ejectors. As a rule, design and engineering safeguards appear to be employed preferentially to administrative (i.e., procedural) safeguards, as stated in the BNFL hazards control strategy.

One method of mitigating potential hazards is the use of redundant systems. For example, a backup source of power to maintain vessel vent flow would greatly reduce the possibility for cell contamination and cell ventilation system loading. Review of the fault schedules identified the limited use of redundant systems for the express purpose of hazard mitigation. However, credit was taken for a redundant system being considered as a mitigating factor when there was redundancy of process purposes (e.g., Event Identifier 1/0, Entrained Solids Removal, External Dose Hazard, cites two banks of ultrafilters as a safeguard, presumably from a blocked ultrafilter initiating event). Therefore, the Contractor appears to have achieved a balanced approach in the control of radiological, nuclear and process chemical hazards by tailoring.

3.6.1.1.3 Cesium and Technetium Removal Using Ion Exchange

The reviewers evaluated the hazards control strategies or "safeguards" presented in HAR, Section 5.2.5, "Cesium Removal Using Ion Exchange," and Section 5.2.7, "Technetium Removal Using Ion Exchange."

The Contractor's suites of potential hazard control strategies are necessarily broad, but appropriate to the current level of design development (conceptual design). The potential control strategies are defined sufficiently well to permit selection of corresponding codes and standards for the design of the hazard control systems and devices. Specifically, the Contractor intends to: (1) locate the process equipment in hot cells; (2) provide instrumentation to detect cesium breakthrough; (3) monitor the resin performance for each use cycle and to add fresh resin before degradation; (4) monitor temperature and pressure in the columns; (5) provide passive design features to prevent explosive gas mixtures in the process vessels and vent system; (6) provide for isolation of the vent system, and fire suppression in the event of a fire; (7) provide cooling water jackets for decay heat removal from the cesium ion-exchange columns; (8) provide for containment and monitoring of leakage from the process equipment; and (9) provide interlocks and column cycle procedures that prevent inadvertent mixing of acid and caustic.

More specificity in hazard control strategies cannot be justified until the risks posed by the process hazards are more clearly understood and placed on a more quantitative basis. Process design development (to the stage where process and instrumentation drawings, for example, can be prepared and reviewed) will permit postulated accidents to be defined with more specificity. The enhanced understanding of potential accident initiators should then provide a stronger basis for binning of potential accident frequencies. The increased confidence in the level of risk posed by the postulated unmitigated accidents will allow selection of specific control strategies. This will ensure the tailoring of individual hazards into a more comprehensive set of potential accidents. However, the reviewers judged that the suites of hazards control strategies identified in the submittal provide an acceptable basis for standards selection, consistent with the current stage of design development.

3.6.1.1.4 Cesium/Technetium Nitric Acid Recovery and Resin Addition/Removal Systems

The reviewers evaluated the hazards control strategies or "safeguards" presented in HAR, Sections 5.2.8, "Cesium and Technetium Nitric Acid Recovery Systems," and 5.2.9, "Cesium and Technetium Fresh Resin Addition."

The Contractor's suites of potential hazard control strategies are necessarily broad, but appropriate to the current level of conceptual design development. The potential control strategies for the cesium/technetium nitric acid recovery system are adequately defined to permit selection of corresponding codes and standards commensurate with the current level of design development. Specifically, the Contractor intends to (1) design the vent system to prevent accumulation of explosive gas mixtures and to contain acid gases using stainless steel construction, (2) design the cell sump to detect and contain leaks, (3) minimize combustibles in the cells, and (4) design the SSCs commensurate with their safety function in mitigating seismic events.

The control strategies or "safeguards" identified by the Contractor to prevent or mitigate the consequences of each event for the resin addition and removal system are also appropriate.

Specifically, the Contractor intends to (1) design equipment to avoid erosion, (2) verify proper ion-exchange operation, (3) design valve sequence controls to prevent misalignment, (4) store nitric acid and resin in separate areas and avoid ignition sources, (5) prevent and mitigate leakage and spills by providing for vessel overflow protection and by providing for detection and collection of leaks, and (6) prevent radiation shine through empty piping.

3.6.1.1.5 Cesium Recovery as a Solid

The reviewers evaluated the hazards control strategies or "safeguards" presented in HAR, Section 5.2.6, "Cesium Recovery as a Solid."

The Contractor's suites of potential hazard control strategies are necessarily broad, but appropriate to the present level of design development. The potential control strategies for the cesium recovery as a solid system are adequately defined to permit the selection of corresponding codes and standards for the design of the hazard control systems and devices. Specifically, the Contractor intends to (1) prevent and mitigate the consequences of dropped loads by appropriately controlling crane movements, using a high-integrity canister design, confining lifting movements to cells, and by designing the cell ventilation dampers to close following an incident; (2) ensure the CST is dry by checking the drying gas before sealing the canisters; and (3) prevent overflow into the vessel vent system by including interlocks on the high level sensor.

In response to Question 32, the Contractor committed to investigate the need to remove bound water in the CST drying step and to amend the drying process, as needed, to control hazards associated with hydrogen generation from bound water radiolysis in the sealed containers.

3.6.1.1.6 LAW Melter Feed Evaporator

Specific hazards and proposed control strategies are presented in the HAR. Section 5.2.10, "LAW Melter Feed Evaporator," provides fault schedules for the LAW melter feed evaporator. Appendices A and B contain additional hazard analyses.

The Contractor did not attempt to identify every initiating event or to explicitly link one or more specific hazard controls to mitigate each initiating event. The Contractor's stated intent was to identify worst-case hazards, hazard consequences, plausible initiating events, and possible safeguards. This is consistent with the hazards review strategy used by the Contractor for this analysis. In general, the proposed safeguards are reasonable and consistent with engineering practices employed at similar facilities. The reviewers concluded that an assessment of the completeness of the safeguards should not be conducted until completion of detailed design and engineering activities.

The primary hazards for the melter feed evaporator are the generation of liquid and aerosol/gaseous discharges due to equipment failure or process upsets (e.g., Event Identifier 1614661/145). The control strategy encompasses the application of physical containment and filtration capabilities. Liquid discharges from equipment will be retained by steel-lined concrete cells constructed with sump collection systems. The cell ventilation will be designed to capture airborne contaminants. This is consistent with the hazard control strategy used for similar facilities. Short of a catastrophic failure of a subsystem, control strategies for hazards initiated by process upsets or operator or equipment failure are not defined at this time. This is consistent with the conceptual nature of the design. For example, in Event Identifier 1614661/129, "Loss of

Water Hazard," safeguards are identified as follows: "Low flow alarm on cooling water". Even though worker and public consequence rankings of 2 are estimated, a backup source of water has not yet been identified. One method of mitigating potential hazards is the use of redundant systems. Review of the fault schedules did not reveal a significant use of redundant systems for the express purpose of hazard mitigation.

The BNFL HAR indicates that design and engineering safeguards are generally specified in preference to administrative (i.e., procedural) safeguards. Also, the Contractor achieved a balanced approach in the control of radiological, nuclear, and process chemical hazards.

3.6.1.1.7 LAW and HLW Glass Melters

RL/REG-97-08, in order to provide a documented basis for the standards utilized in implementing the hazards control, requires the Contractor to establish adequate hazards control strategies for the hazards associated with process elements.

The Contractor did not attempt to identify every initiating event or to explicitly link one or more specific hazard controls to mitigate each initiating event. The Contractor's stated intent was to identify worst-case hazards, hazard consequences, plausible initiating events, and possible safeguards. This is consistent with the hazard review strategy used by the Contractor for this analysis. With the exceptions discussed in subsequent paragraphs, the initial (preliminary) safeguards that BNFL proposed are reasonable and consistent with engineering practices employed at similar facilities. The reviewers noted that BNFL's assessment for completeness of the safeguards should be conducted upon completion of detailed design and engineering activities.

In general, the Contractor selected the appropriate safeguards for the initiating events. Of note, is that cell design features will provide containment for nearly all melter accidents. Because the design is still conceptual, BNFL was not yet able to take credit for all sensors, interlocks, and redundant systems.

In several cases, the Contractor was not reasonable and consistent with engineering practices employed at similar facilities for the selection of safeguards. BNFL did not take credit for safeguards that existed in the system. One example is not taking credit for the water-cooled melter jacket for glass containment (see Fault Schedules 3200/179 and 3200/246). The water cooling of the melter shell, although discussed in the process description, is not considered as a safeguard to glass leakage. Another example is not taking credit for the control of the feed and glass chemistry to safeguard against some of the melter pressurization events. One such event is the glass foaming discussion in Fault Schedules 3200/180 and 3200/262. The primary safeguard against foaming in the melter should be proper control of the glass chemistry (i.e., prevention). Omission of a proper safeguard was also identified for Fault Schedule 3200/153, Glass Former Feed System to LAW Concentrate – Domino Hazard). No safeguards are identified for corrosive or metallic streams causing damage to the melter or process equipment. A safeguard to this initiating event should be to maintain the chemistry of the feed and scrubber solutions within pre-established operating conditions via a strict analytical sampling program.

The reviewers disagreed with a number of the safeguards identified and noted that some are not included in the suite of identified candidate controls. However, the reviewers determined that the lack of a comprehensive suite of controls is commensurate with the early stage of the current melter design. Fault Schedules 3200/257, "HA Glass Melter - Water Loss Recirculation Hazard," and

3200/175, “LA Glass Melter - Water Recirculation Lost,” state that after a loss of water, “water may be re-introduced slowly such that steam is not generated.” This appears to be an error. Water could be reintroduced slowly so that the resulting steam does not over-pressurize the water jacket, but this would be dangerous. Also, the emergency cooling water supply to the melter is not considered to be a safeguard against these initiating events. The melter emergency cooling water supply is only discussed in the Feed Tank fault schedule. Fault Schedule 3200/230, “HA Melter Feed Tanks - Loss of Water Hazard,” states that the emergency cooling water to the melter is available to the feed tank. This appears to be an improper use of the melter emergency cooling water.

Overall, design and engineering safeguards appear to be employed preferentially to administrative (i.e., procedural) safeguards, as a rule. In addition, the Contractor achieved a balanced approach in the control of radiological, nuclear, and process chemical hazards.

3.6.1.1.8 Vitrification Offgas Treatment

Specific hazards and proposed control strategies are presented in the HAR. Section 5.2.12, “LAW Vitrification Offgas Treatment and Emergency Offgas Systems,” provides fault schedules for the vitrification offgas treatment processes. Appendices A and B contain additional hazard analyses.

The Contractor did not attempt to identify every initiating event or attempt to explicitly link one or more specific hazard controls to mitigate each initiating event. The Contractor’s stated intent was to identify worst-case hazards, hazard consequences, plausible initiating events, and possible safeguards. This is consistent with the hazards review strategy used by the Contractor for this analysis. In general, the safeguards proposed are reasonable and consistent with engineering practices employed at similar facilities. The reviewers concluded that an assessment of the completeness of the safeguards should not be conducted until completion of detailed design and engineering activities.

There are two primary hazards for the vitrification offgas treatment processes. The first is the release of gaseous, and to a lesser extent liquid, contaminants to the operating cell environment due to equipment failure or process upsets (e.g., Event Identifier 1614687/164, “LAW Vitrification Emergency Off-Gas System, External Dose Hazard.”) The second is a failure of the NO_x selective catalytic destruction system that results in either a fire or explosion hazard or the release of NO_x from the plant stack in concentrations that exceed safety limits (e.g., Event Identifier 1614672/239, “LAW Vitrification Off-Gas Treatment, Explosion/Overpressure Hazard”). For the first set of hazards, the control strategy relies on the operation of emergency offgas systems to support the primary offgas systems. The use of emergency offgas treatment systems is consistent with the hazard control strategy of similar facilities. These systems are designed to operate in the event that the primary system fails for one reason or another (e.g., line blockage, subsystem failure, etc.). The systems are also intended to “assist” the primary offgas treatment system in the event of a steam/gas surge from the melters. At this point in the design, it is clear that the emergency offgas system cannot handle the six surge volumes that have been documented as probable and likely to occur. The process description indicates that the primary and backup systems are designed to handle “surge flows 50% above normal gas flowrate” and that halting the flow of feed to the melter “normally prevents over-pressurization.” These assumptions are not supported by first-hand experiences of some of the reviewers. The consequences of improper mitigation of these potential accidents are (1) increased gaseous discharges to the cell environment, and (2) uncontrolled discharges of glass to the overflow section and storage containers, which can lead to higher equipment maintenance or failure. Both events will raise the potential for worker dose, due to higher exposures to contamination.

The control strategies described to mitigate or prevent hazards associated with the NO_x destruction system have been adequately addressed, with the possible exception of the potential for downstream formation and accumulation of ammonium nitrate. At this time, the hazard control methodology is simply stated as "System parameters are controlled to prevent formation of ammonium nitrate." Specific information to be provided during detailed design must be evaluated in order to determine the adequacy of this strategy.

One method of mitigating potential hazards is the use of redundant systems. For example, a backup source of power used to maintain primary offgas treatment system flow would reduce the possibility for cell contamination and cell ventilation system loading. Review of the fault schedules did not reveal significant use of redundant subsystems for the express purpose of hazard mitigation.

The HAR indicates that design and engineering safeguards are generally specified in preference to administrative (i.e., procedural) safeguards. In addition, the Contractor achieved a balanced approach in the control of radiological, nuclear, and process chemical hazards.

3.6.1.1.9 Container Decontamination Process

The LAW/HLW container decontamination hazard controls are found in HAR, Section 5.2.16, "LAW/HLW Container Decontamination System." Various candidate controls are identified for the container decontamination hazards, including: administrative controls on worker access to the decontamination cell, in-cell radiation monitors to detect accumulation of glass fragments, interlocks to prevent erosion of canisters during decontamination due to failure of the water cleanup system, and a decontamination booth in the cell to contain waste water from the decontamination process. The identified controls in combination with the qualitative consequence and frequency rankings are adequate to permit the selection of standards to implement the controls.

3.6.1.1.10 Support Systems

Seven TWRS-P support systems, listed below, are included in the HAR. The respective section of the HAR in which the systems are listed is also shown. The support systems are discussed in the following sections of this Evaluation Report, in the order listed below:

- LAW Vitrification Emergency Offgas System: Section 5.2.12
- Secondary Offgas Treatment System: Section 5.2.15
- Plant Waste Management System: Section 5.2.17
- Outcell Process Reagents System: Section 5.2.18
- Boiler Water Heat Recovery System: Section 5.2.19
- Mechanical Handling System: Section 5.2.20
- HVAC Systems: Section 5.2.21

3.6.1.1.10.1 LAW Vitrification Emergency Offgas System

The suites of candidate hazard controls (safeguards) proposed by BNFL for the LAW Vitrification Emergency Offgas System are presented in HAR, Section 5.2.12.2.

Examples of such safeguards include: appropriate materials of construction will be selected to avoid corrosion caused by chlorides and fluorides in the feed; the melter design allows glass to discharge as a result of an over-pressurization caused by a damper failing to close in the offgas line (safe failure modes of dampers will be considered in the detailed design); active ventilation systems sweep flammable gases (e.g., hydrogen produced by radiolysis of the waste) out of process vessels and maintain flammable gas concentrations well below the lower flammability limit (Question 180). The safeguards proposed for potential ignition of paper filter cartridges in HEPA filters include (1) restrictions on the number of possible ignition sources (e.g., no pumps are used in the area), (2) restrictions on the fire loading, and (3) process gas temperature is probably too low to ignite the paper cartridge. Safeguards proposed for loss of utilities (process air, electric power, and water) which may result in loss of valve actuation, loss of instrumentation, loss of ability to transfer fluids, and/or loss of damper actuation include (1) battery backups of electrical power, (2) shutdown of feeds to the melter if electrical power to the offgas system is lost, (3) provision for emergency utility supplies, and (4) ongoing load schedule and service analysis of utilities.

3.6.1.1.10.2 Secondary Offgas Treatment System

The suites of candidate hazard controls proposed by BNFL for the secondary offgas treatment system were presented in HAR, Section 5.2.15.2.

For example, equipment design to ensure that passive ventilation can adequately ventilate the melters is proposed as a safeguard in the event that (active) ventilation fans fail. The safeguards proposed to prevent pressurization of the ventilation system caused by a plugged HEME (with concomitant loss of containment upstream of the HEME and potential increased dose uptake to workers) include: (1) two differential pressure measurements on the wet scrubber, (2) measurement of pressure in the vessel vent system, and (3) measurement of pressure drop across the HEME. Fires caused by hydrogen accumulation in the offgas treatment system are prevented by: (1) dilution of hydrogen concentrations to below 1% at points of origin, (2) further dilution of the hydrogen in the secondary offgas, and (3) restricting the fire load in the system.

The safeguards preventing increased internal doses of iodine to workers and/or the public caused by adverse chemical reactions generating iodine include: (1) providing for measurement of level in sump pots and monitoring of differential pressure across the pots, (2) specifying HEMEs with decontamination factors (DFs) of ~100, (3) designing the scrubber to provide an additional DF of ~100, and (4) providing for local controls to prevent iodine generation and release to the secondary offgas system.

The safeguards proposed to prevent HEPA filter collapse (with concomitant increased dose uptake to the public) due to water ingress (dependent on the dewpoint of the vent stream) resulting from loss of electrical power include: (1) backup electrical power (diesel motor/generator), and (2) battery backup electric power for the critical instrumentation.

Safeguards preventing accidental discharge of radioactivity to the atmosphere caused by loss of chilled water or loss of process water to the scrubber include: (1) an offgas treatment system design which can tolerate loss of water for short periods, and (2) low water level indication in the scrubber.

3.6.1.1.10.3 Plant Waste Management System

The suites of candidate hazard controls proposed by BNFL for the plant waste management system are presented in HAR, Section 5.2.17.2.

For example, in the condensate/plant wash and drain systems, the proposed safeguard against leakage caused by corrosion is the selection of appropriate materials of construction; also, steam and water will be treated or purified ("conditioned") to render them less corrosive. The proposed safeguard against accidents involving dropped loads from cranes, mini-manipulator, cable or block failure is a lifting beam to assist in any heavy lifting (e.g., in glove boxes). Pressure vessel V9305 will be protected from an explosion caused by excessive pressure (with contamination spreading throughout the cell) by designing the vessel against the worst-case pressure (3 bar). A building fire protection system and restrictions on the quantity of fuel stored in the building are the proposed controls against diesel fuel fires. Cells or drip trays are proposed safeguards against loss of containment accidents involving overflow of vessels. The Treated Effluent Disposal Facility and the Effluent Treatment Facility will be continuously available to prevent backup of waste in the lines that feed to them, with the potential for spills in the TWRS-P facility. (According to BNFL, DOE will pay penalties if these facilities are unavailable.) Possible safeguards have not yet been identified against a loss of caustic supply, which may result in radioactive iodine release to the secondary offgas system if acid is not neutralized; but at least this potential accident is recognized. Safeguards proposed against accidents involving compromise to shielding include locating potentially active vessels in cells, locating maintainable items such as pumps in bulges (certain vessels will be located in rooms with restricted access), and shielding assessments have been conducted for offgas with higher activity levels. Proposed safeguards against malfunctioning of gamma gates include key operation to prevent operators from becoming locked in the flask introduction area, locating controls of the gamma gates outside the introduction area, keeping gamma gates closed during operations, and radiation monitoring. Proposed safeguards against accidental increased emissions of radioactive iodine from the stack caused by generation of gases in active tanks include design provisions for venting active tanks in process cells to the vessel vent system, which will be capable of handling any flashing steam from the tanks.

3.6.1.1.10.4 Outcell Process Reagents System

The suites of candidate hazard controls proposed by BNFL for the Outcell Process Reagents System are presented in HAR, Section 5.2.18.2.

For example, the safeguards proposed to prevent accidents resulting from incorrect feeds or misrouting of waste include interlocks and adequate record-keeping. Safeguards proposed to prevent accidents involving highly exothermic reactions include interlocks to prevent acid addition to water in a tank, metered flow into tanks, and limiting the inventories of flammable or explosive materials in the vicinity of tanks. The proposed safeguard against accidents involving dropped loads during maintenance of pumps, for example, involves strategic routing of lifted objects. Trace heating of vessels containing bulk chemicals is a proposed safeguard against an accident involving freezing of the bulk chemical (e.g., caustic soda). The proposed safeguards for preventing accidents caused by mixing of incompatible chemicals include bunding of tanks, design provisions for the tanks to eliminate the need to pressurize them, sealing the tanks, controlled access to tanks, requirements for analyzing contents of tanks before delivering chemicals, and minimizing the holdup of chemicals in process lines (minimizes the quantities of chemicals if mixing of incompatible chemicals should occur). Safeguards against accidents resulting from loss of utilities (air, power, and cooling water) include provision for backup electrical power supplies. Loss of instrument air is considered to be a problem only while performing a function such as transfer of waste or material in process.

3.6.1.1.10.5 Boiler Water Heat Recovery

The suites of candidate hazard controls proposed by BNFL for the boiler water heat recovery system were presented in HAR, Section 5.2.19.2, "Boiler Water Heat Recovery Fault Schedule."

For example, the proposed safeguard against accidental loss of containment caused by water hammer (two-phase flow) is the provision of properly sized pipework to accommodate two-phase flow. Adverse chemical reactions in this system could be caused by delivery of the wrong chemicals for the makeup and dilution tanks; proposed safeguards include the requirement to analyze reagent tank contents before reagents are delivered. Proposed safeguards against accidental spillage or leakage of very hot water due to corrosion in feed lines or tanks include design provisions to optimize layout of the plant so that gravity drainage may be used, where appropriate.

3.6.1.1.10.6 Mechanical Handling System

The suites of candidate hazard controls proposed by BNFL for the Mechanical Handling System (LAW Vitrification Line Product Handling) are presented in HAR, Section 5.2.20.2.

For example, proposed controls to prevent shinepath to workers include layout and design of the decontamination cell, eliminating contamination, and good housekeeping. Proposed safeguards against loss of containment accidents caused by buildup of gas inside containers include provisions for extracting gases from the containers. Safeguards have been proposed for dropped load accidents in the LAW Vitrification Line Product Handling system, including good design practice, provision of recovery routes in the event a load is dropped, design provisions to ensure container stability, design of the hoist and grappling mechanism, use of high-integrity containers, crane speed controls, and provision for adequate interlocks on mechanical handling components. Fires involving ignition of cabling, for example, could cause general fires in areas; proposed safeguards include protection of cables from hot materials (e.g., molten glass), cell operating procedures, and provision for emergency procedures following glass spillage. Accidents involving export of containers carrying loose external contamination can result in contamination of the transport tunnel and store with increased dose uptake consequences to workers; proposed safeguards include requirements for decontamination of containers after filling. Loss of welding gas could result in incomplete container welds after filling containers, with the potential for loss of containment and exposure of personnel to radioactive materials; proposed safeguards include providing indications of welding gas pressure and gas flow.

3.6.1.1.10.7 HVAC Systems

The suites of candidate hazard controls proposed by BNFL for the HVAC systems are presented in HAR, Section 5.2.21.2, "HVAC System Fault Schedule."

Examples of hazard controls proposed by the Contractor include provision of two-stage filtration in filter caves and recirculation of air for accidents involving release of radioactive material and possible increased dose uptake to workers and the public during decontamination activities.

Proposed controls for preventing in-cell fires (e.g., caused by melter upsets), which can challenge the integrity of filter systems, include a design provision for recirculation of air and requirements for disconnecting the electric power to the melters. Loss of chilled water could cause loss of cooling capability in a melter cell, which may challenge the structural integrity of the cell. The proposed control for this accident is a cell design which will be unaffected by any credible temperature excursions. Accidental plateout of radioactive dust in a duct downstream of a failed filter could result in potential for increased activity uptake to workers. Proposed controls include monitoring of activity downstream of filters, provision of standby filter banks if a set of filters breaks through, and ductwork routing such that plate-out is minimized. The proposed controls for accidents involving faults in a filter-crushing machine and breaches of ductwork that have the potential for causing increased dose uptake to workers will be the subject of further hazard analysis, as the process design progresses.

Conclusions

Specific control strategies are not identified for hazard mitigation, principally because the early stage of the facility design makes the selection of such specific strategies premature. The Contractor's suites of potential hazard control strategies are necessarily broad, but appropriate to the present level of process development (conceptual design). The potential control strategies are adequately defined to permit selection of corresponding codes and standards for the design of the hazard control systems and devices.

In general, the reviewers concluded that process control strategies were appropriate and reasonable, and comparable to control strategies at similar facilities. The reviewers concluded that BNFL's hazards analysis associated with water removal during cesium recovery, accidents involving HVAC filter machine crushing, and breaches of HVAC ductwork required additional assessment. BNFL committed to perform these assessments during Part B.

The conclusions are qualified by the expectation that the Contractor will further evaluate the potential for accumulations of flammable gases in process vessels (i.e., the feed receipt tank and cesium storage tank) as the TWRS-P design progresses. The need for engineering controls or design features to prevent flammable gas accumulations also will be evaluated.

3.6.1.2 Facility Hazards Control Strategies

Requirements

DOE/RL-96-0003, Section 4.1.2, "Contractor Input," states: "The Standards Approval submittal package shall consist of the following documentation...4) The hazards control strategy implemented in the design and proposed operations."

Review Methodology

The reviewers considered the following questions during the evaluation of each hazard control strategy:

- Was the control strategy appropriate and reasonable for the selected safety (protection) function(s) and its characterization (e.g., highly reliable for all operating modes and under accident conditions)?

- Was the control strategy for each hazard (or class of hazards) consistent with, or appropriately different from, strategies used to control similar hazards in similar settings (e.g., the Defense Waste Processing Facility [DWPF] or the West Valley Demonstration Project [WVDP])?

- Did the Contractor designate a reasonable control strategy from a number of strategies, if several control strategies were still under consideration for a given hazard or class of hazards?

Evaluation

3.6.1.2.1 Wet Chemical Storage Building

Hazard controls were not selected by BNFL for the operations involving chemical hazards in the Wet Chemical Storage Building. In response to Question 34 concerning the lack of a hazard analysis in the submittal for bulk chemical storage, the Contractor responded that "because the level of design for bulk chemical storage (outcell) for Part A design was not sufficiently developed to support the PHA study, a safety review was conducted to approved BNFL procedures, which examined the schematics submitted on (cold) bulk chemical storage." Each of the "cold" chemical systems was reviewed, hazards identified, and recommendations given to the designers for further design development work. These recommendations were not control strategies, but rather precursors to aid the designer in ensuring that suitable hazard control was being built into the design. For example, a potential hazardous situation of loss of concentrated nitric acid was identified; the recommendation in the safety review was that the bermed (i.e., "diked") area within which the nitric acid storage vessel is situated must be acid resistant (i.e., the design is to incorporate suitable acid resistant areas). The Contractor committed to a more detailed safety assessment of these systems during design development in Part B (BNFL response to RU Question 34). The reviewers determined the Contractor's response to the question to be acceptable. As an interim measure, the Contractor provided a supplemental response to Question 34 indicating that the HAR will be revised to note the existence of the bulk (cold) chemical safety study with its major conclusions.

3.6.1.2.2 Glass Formers Storage Building

Hazard controls were not identified by BNFL for the operations involving chemical hazards in the Glass Formers Storage Building. In response to Question 34 concerning the lack of a hazard analysis in the submittal for bulk chemical storage, the Contractor responded that "because the level of design for bulk chemical storage (outcell) for Part A design was not sufficiently developed to support the PHA study, a safety review was conducted to approved BNFL procedures, which examined the schematics submitted on (cold) bulk chemical storage." However, in a supplemental response to Question 34, BNFL stated that the glass former chemicals were not included in the safety review of the bulk chemical storage areas. The Contractor committed to a more detailed safety assessment of these systems during design development in Part B (BNFL response to RU Question 34), and thus the reviewers found the Contractor's response acceptable.

3.6.1.2.3 Other Buildings

HAR, Section 2.2.5, "Other Buildings," notes that the Melter Assembly Building, Empty Container Storage Building, Services Building, and Administration Building were not included in the hazard evaluation, as they do not contain significant quantities of hazardous materials. In addition, the reviewers noted that a hazards evaluation was not conducted for the Immobilized Waste Container Shipping Building. BNFL has therefore not selected hazard control strategies for these buildings.

Conclusions

The reviewers concluded that BNFL had not identified facility hazards control strategies due to the limited facility design information at this stage of conceptual design. The reviewers concluded that BNFL's commitment (in its response to Question 34) to perform process hazard analyses for the "bulk chemical" hazards (in the Wet Chemical Storage Building and Glass Formers Storage Building) as the design matures during Part B is acceptable. Analysis of the advanced design in Part B should result in the selection of appropriate hazard control strategies.

3.6.1.3 Control of Selected Hazards

3.6.1.3.1 Fire Protection

The Contractor has acknowledged and documented that fire can be a major contributor to risk. At this stage of conceptual design, BNFL has identified only a limited set of fire hazards and fire scenarios. Nevertheless, BNFL has proposed to implement and maintain a comprehensive fire safety program that reflects programmatic and facility-specific fire protection measures. These measures, if completely and correctly implemented, will achieve sufficient fire hazard defense in depth. The manifestation of what this program will encompass can be found in the BNFL SRD, Vol. II, Section 4.5, "Fire Protection."

Where specific fire hazards have been delineated, a preliminary hazard control strategy has been identified. Subsequent revisions to these strategies are anticipated as design and fire hazards analyses progress. At this stage of conceptual design, the documentation reveals that the Contractor intends to rely on a multi-faceted approach to fire hazard mitigation. This includes the implementation of fire prevention policies and procedures; the reliance on an adequate staff of trained personnel, including emergency responders; the use of noncombustible and fire-resistant construction; the provision of automatic fire protection systems; and the maintenance of an infrastructure (such as the fire protection water supply) that will facilitate the effective intervention of the site fire department, among other aspects.

With regard to the specific nature of the fire hazard mitigation strategy, the Contractor has adopted the relevant National Fire Protection Association (NFPA) codes and standards as well as the appropriate DOE fire safety criteria. These will provide reasonable assurance that the particular programmatic and facility design features will be configured in an acceptable manner. Because the overall approach to hazards mitigation is based on conformance with NFPA standards as supplemented by DOE criteria, the reviewers determined BNFL is consistent with fire protection programs found within the nuclear industry.

3.6.1.3.2 Criticality Hazard Controls

The BNFL HAR contains a preliminary assessment of candidate criticality hazard controls. The fault schedules in the HAR identify criticality hazards in the LAW and HLW feed receipt tanks, the LAW technetium removal IX columns, the LAW IX column resin, and the HLW melter vessel. The HAR identifies the following candidate controls for criticality hazards: independent sampling and verification of feed specifications; internal wash rings in the HLW feed receipt tanks, shielding for in-cell operations; and flushing of IX columns. It appears that the level of detail in the selected criticality hazard controls anticipated the following assumptions: (1) the claim that fissile material concentrations will be low in the process streams (see Section 4.6.2 for a discussion on criticality), and (2) that a detailed criticality evaluation will show that criticality is not credible and no design modifications are required to control this hazard. Consequently, the link between the hazard analysis and the safety criteria selected for criticality results in only a very general recognition that criticality is a potential hazard. There is little discussion (see Section 6.2.2 of the BNFL HAR) of candidate criticality controls or risk-informed selection of criticality controls in the BNFL HAR, which is consistent with the expectation that no controls are needed.

Conclusions

With respect to control of selected hazards, specific control strategies were not identified for hazard mitigation, principally because the early stage of the facility design makes the selection of such specific strategies premature. The Contractor's suites of potential hazard control strategies are necessarily broad, but appropriate to the present level of process development (conceptual design). The potential control strategies are adequately defined to permit selection of corresponding codes and standards for the design of the hazard control systems and devices.

The reviewers concluded that the absence of nuclear criticality controls and alarm systems in the Contractor's submittal requires a more careful and detailed analysis. Specifically, the Contractor needs to address the potential for criticality excursions and the inclusion in future submittals of the necessary technical arguments for and against the need for criticality controls. The Contractor committed to include the rationale for the conclusion that criticality excursions in the TWRS-P process are not possible in the BNFL Initial Safety Analysis Report (ISAR), Chapter 6 (Question 26). In the assessment of the ISAR, the reviewers determined that the rationale BNFL provided in the ISAR was insufficient to support that the absence of nuclear criticality controls and alarm systems. Therefore, the Contractor's overall treatment of criticality requires resolution during Part B.

3.6.2 Adequacy of Standards Selected

Requirements

DOE/RL-96-0003, Section 4.1.2, "Contractor Input," states: "The Standards Approval submittal package shall consist of the following documentation:...1) The Contractor's recommended set of radiological, nuclear, and process safety standards for design, construction, operation, deactivation, and regulatory submittals in the form of a SRD."

Review Methodology

The reviewers evaluated the adequacy of the Contractor's conformance to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006. The information provided by BNFL was assessed to the following attributes:

- Adequacy of Standards: The adequacy of the standards for implementing the hazards control strategy for the process element under consideration was evaluated. The standards to be evaluated may be either specific limits or selected means. Specific limits are those limits that the Contractor has adopted for the purpose of providing adequate protection in specified hazardous situations (e.g., hydrogen concentration limits to ensure protection against adverse effects of hydrogen). Selected means are those means by which hazards control strategies (in terms of physical features or human activities) are to be achieved.

- Use of Precedents: The Contractor selected standards that represent recognized precedents for adequately fulfilling the intended purposes (e.g., endorsed by the DOE or NRC, nationally recognized and endorsed, proven by internal use, etc.). The reviewers should consider the degree to which adequate evidence is presented to justify the use of precedent standards for achieving the specified technical objectives under the circumstances associated with the Contractor's waste processing facility.

Evaluation

BNFL linked the suite of potential hazards controls to its choice of implementing safety criteria in the SRD (see Attachment 4, Tables 1 and 2; BNFL letter 97-RU-0342 dated October 23, 1997; "TWRS Privatization Contract No. DE-AC06-RL13308; Response to RU Letter 97-RU-0307, October 3, 1997). To identify "safety criteria" or standards to implement the hazards controls, the Contractor grouped the hazards controls into categories (e.g., fire and criticality controls) and identified candidate implementing standards for each category.

In general, BNFL selected national consensus codes and standards as implementing standards for SSCs based on the design classification associated with the safety criteria. Design Class I SSCs were those structures, systems and components required to protect the public and Design Class II SSCs were those structures, systems and components required to protect the worker. The reviewers determined that the BNFL approach to SSC classification, that is Design Class I and Design Class II, was unacceptable and not in accordance with the privatization contract. The BNFL approach was unacceptable because the proposed design classification scheme provided a lesser level of protection for the worker than the public. An example was that Design Class I components required single failure protection and Design Class II did not. The BNFL approach did not adhere to the TWRS-P contract because all SSCs required for public, worker and co-located worker protection were required to be classified as important to safety. Also, pre-selection as Design Class I and II did not follow the precepts of Integrated Safety Management (ISM) because control strategies should base on risk and consequences instead of public and worker. In BNFL letter W338-98-0004 dated February 19, 1998, the Contractor committed to establish a categorization scheme that adhered to the contract. Accordingly, the safety criteria that refer to either Design Class I or II will require revision.

3.6.2.1 General Design

BNFL selected a set of general top-level safety criteria for the design of SSCs that are relied upon to protect the public (DC I) or the workers (DC II). To meet the top-level safety criteria, BNFL has selected implementing codes and standards that specify design and quality standards to be applied to the TWRS-P facility design. Specific requirements are delineated in Safety Criteria 4.1-2, 4.1-3, and 4.1-4 for the design of buildings and other structures designated as DC I and DC II.

The adequacy of the codes and standards selected for DC I building design, construction and fabrication, testing, and inspection was reviewed. The reviewers determined that the implementing codes and standards are either national consensus codes and standards or DOE Standards. These national consensus codes and standards have been used in the commercial nuclear industry or in design modifications of other DOE facilities. These codes and standards, when properly implemented, will ensure quality standards commensurate with the importance of the safety functions to be performed by Design Class 1 structures and will provide an adequate basis to support TWRS-P facility design.

The implementing codes and standards selected for Design Class II SSCs also are recognized national consensus codes and standards or relevant DOE Standards. However, the severity of the natural phenomena effects to be considered in the design of Design Class II SSCs, which are more appropriate for ensuring occupant life safety, has not been adequately justified as being appropriate for such safety functions as radioactive material confinement.

BNFL has specified equal hazard spectra developed from a site-specific probabilistic hazard study for seismic design of Design Class I SSCs and for Design Class II SSCs where seismically induced failures of such SSCs can cause unacceptable consequences. For other Design Class II SSCs, the seismic design will be in accordance with the Uniform Building Code (UBC) for “essential facilities.” BNFL has identified DOE-STD-1020 as the applicable implementing standard for the seismic design criteria. However, DOE-STD-1020, in conjunction with DOE-STD-1023 (not referred to in the SRD), delineates how design basis earthquake (DBE) spectra should be generated from equal hazard spectra developed from a probabilistic seismic hazard study. Also, DOE-STD-1020 requires that SSCs designed as essential facilities, in accordance with UBC, need to consider appropriate site-specific seismic spectra instead of UBC seismic provisions, if the former is found to be more conservative. The SRD does not address the appropriateness of the selected spectral shape. However, BNFL has indicated in its response to Question 12 that further justification of the response spectral shape will be included in the BNFL ISAR.

BNFL has cited DOE-STD-1020 as the reference document for not imposing any requirements for designing SSCs to withstand tornado and tornado missile effects. However, DOE-STD-1020 tornado hazard estimates were performed more than10 years ago. This estimate and the associated tornado hazard methodology needs to be reviewed against more current methodology studies to ensure that the deletion of the tornado hazard for the TWRS facility is appropriate and conservative. The reviewers informed BNFL that the tornado hazard assessment approach in DOE-STD-1020 is currently being reviewed. In response to Question 12, BNFL has indicated that the tornado hazard will be discussed in the ISAR.

3.6.2.1.1 Mechanical Systems and Components

The reviewers evaluated the adequacy of the selection of standards that address mechanical systems. This review entailed comparing the requirements stated in the SRD against standards that were applied in the design or modification of other DOE facilities. The standards selected by BNFL for the design of the TWRS-P mechanical systems have been reviewed and found to provide an adequate basis to support the TWRS-P facility design.

BNFL has selected ASME Standard B31.3 for piping design. However, ASME B31.3 is not generally used in the nuclear industry for safety class piping systems. This standard has been used for the design of liquid radwaste system piping at nuclear power plants. With the selection of ASME B31.3, BNFL has prejudged the hazards and potential accident consequences associated with the TWRS-P facility to be comparable to those of a radwaste processing system at a nuclear power plant. A qualitative assessment of the hazards in TWRS-P indicates that the hazards and potential accident consequences may be greater due to higher inventories of long-lived ^{137}Cs and transuranics (TRUs) in system tanks and process streams relative to those same radiochemicals in a nuclear plant liquid radwaste processing system. Also, the presence in TWRS-P of chemicals used for chemical separation and other vitrification processes that are not found in a radwaste system may increase the hazards or may pose corrosion/erosion hazardous situations absent from nuclear power plant liquid radwaste systems.

The Hazards Analysis clearly shows that radioactivity confinement systems are required at the TWRS-P facility. At least two confinement barriers should be considered in the TWRS-P facility and process design to provide defense-in-depth for the confinement of radioactive materials. The piping system pressure boundary is the first barrier for radioactivity control, and is thus the primary confinement system. The building structure and its associated ventilation systems will be considered to be the second barrier. These barriers are the fundamental safety SSCs that should be considered for designation as DC I. Although the SRD does not specifically state that two confinement barriers will be provided, the selection of standards implies that this design philosophy is being pursued. Appropriate codes and standards have been selected for the building design and the ventilation system design to meet radioactive material confinement requirements. However, it may be inappropriate to select ASME B31.3 as the *only* piping design standard if the system piping is to be the first barrier to accidental radionuclide release.

Overall, the hazards associated with the piping of radioactive liquids at the TWRS-P facility are significantly lower than those associated with reactor coolant systems, but higher than those associated with the radioactive liquid waste cleanup system at nuclear reactors. At this stage of the plant design, it is appropriate to use the standard selected by BNFL for the piping system (ASME B31.3), which is traditionally used for the radioactive liquid waste cleanup system in nuclear power plants. When more detailed accident analyses are performed, it will become clearer whether the TWRS-P facility hazards are more typical of a radioactive liquid waste cleanup system in a typical nuclear power plant, or more in line with those of a reactor coolant system in a nuclear plant. The selection of standards should then be adjusted accordingly by BNFL.

BNFL has indicated in its responses to questions that ASME Section VIII will be used to design the process vessels. Some of the ASME Section VIII attributes for safety class piping system design may be adopted by BNFL to the extent needed to allow the primary piping system to be credited as a confinement barrier in the accident analysis. The implementation of these piping codes will be further defined as the design progresses. When the plant design has reached a more mature stage, the application of specific standards to the design will need to be reviewed to evaluate their appropriateness, particularly if the piping system is to be credited as a confinement barrier. Once this determination is made, selection of appropriate codes and standards can be finalized.

3.6.2.1.2 Electrical Systems and Components

The reviewers evaluated the adequacy of the selection of standards that address electrical systems and controls by comparing the requirements stated in the SRD against standards that were applied to the design or modification of other DOE facilities. It is recognized that both the accident analysis and design development are at an early stage. The standards selected by BNFL for the design of the electrical systems and controls have been reviewed and found to provide an adequate basis to support the TWRS-P facility design.

Issues about the relationship between the BNFL HAR and the selection of codes and standards for electrical systems and controls were identified during the review. In particular, propagation of a failure from the electrical and control systems to various process systems was addressed. BNFL considered failure propagation from electrical systems to process systems in the hazards assessment, and has stated that detailed design will consider the impact of failure of an electrical system on process system control and performance. Position failure of a control valve is cited as an example.

Several standards of the Institute of Electrical and Electronic Engineers (IEEE) for Design Class I power supply systems have been identified in the SRD, implying that safety class power supply and/or control will be used at the TWRS-P facility. The hazard assessment did not specifically conclude whether safety class systems are needed; therefore, it is not known whether these standards will ultimately be used. The linkage between the SRD and the hazard analysis needs to be better established during the ISA stage. BNFL plans to identify the need for Design Class I or II systems as part of the accident analysis and will factor in the impact of Natural Phenomena Hazards (NPH) as part of this analysis.

The reviewers analyzed several systems to determine whether Design Class I or Design Class II electrical systems were needed to mitigate hazards (See Questions 4 and 5 for examples). Clarification to better define the linkage among a given failure event, the associated hazards, and the selected codes and standards was requested. BNFL provided clarifications that were determined to be acceptable.

Electrical systems and control systems will generally provide a support function to the mechanical and chemical process systems at the TWRS-P facility. The safety classification of equipment used in electrical systems and control systems is linked to the classification of the mechanical systems being supported. Therefore, appropriate design standards for design of electrical systems and controls can be finally selected only after the safety classifications (design classes) of mechanical and chemical process SSCs are determined.

3.6.2.1.3 Fire Protection

The Contractor's technical basis for its proposed fire safety program is delineated in a set of fire protection safety criteria and implementing codes and standards presented in Section 4.5 of the SRD. The safety criteria include both programmatic and facility-specific requirements. The safety criteria reflect, to a significant degree, similar requirements that have been promulgated by the NRC and the DOE. Additionally, through the adoption of National Fire Protection Association (NFPA) Standard 801, “Standard for Handling Radioactive Materials,” and DOE-G-440.1, the Department’s Implementation Guide for a comprehensive fire safety program, the Contractor has integrated applicable industry standards and model building code requirements into BNFL’s fire safety program for this facility.

The programmatic-related fire safety criteria reflect the need for a multi-faceted and comprehensive program that includes, but is not limited to, fire safety policies, fire prevention procedures, fire protection equipment, and trained personnel, including an adequate staff of emergency responders. The facility-specific criteria reflect the need for a level of fire protection that is comparable to the best class of industrial facilities in private industry. This includes the need for an automatic fire suppression capability, fire-resistive construction, a fire alarm and signaling system, special fire protection features, emergency egress provisions, adequate water supply for fire fighting, and design features to facilitate the activities of the Hanford Site Fire Department. Collectively, these criteria should, if correctly implemented, achieve fire hazard defense-in-depth.

Considering the fact that these criteria are broadly phrased and performance oriented, there was initial concern that the Contractor had not established a comprehensive standards set that would ensure an adequate level of safety. However, BNFL supplemented the criteria and expanded the set of implementing codes and standards to clearly establish that all applicable fire safety industry codes and standards will form the basis of the fire protection program. Additionally, reflecting the fact that NFPA standards may not always adequately, or comprehensively, address fire safety issues at nuclear facilities, BNFL adopted the appropriate DOE fire protection programmatic guidance and design criteria standards.

3.6.2.1.4 Criticality

BNFL's Safety Criteria 3.3-1 through 3.3-8 are proposed standards for the prevention of criticality accidents. Criterion 3.3-1 is essentially a restatement of DOE/RL-96-0006 Top-Level Principle 4.2.2.5. The remaining BNFL safety criteria are subordinate standards by which the Top-Level Principle 4.2.2.5 will be implemented. For example, the subordinate standards specify that criticality calculations will be performed to verify that the effective neutron multiplication factor does not exceed 0.95 for all credible normal, off-normal, and accident conditions in the facility. The subordinate standards also provide for criticality controls through process design modifications and for alarm systems where fissile material inventories in process exceed certain thresholds and a criticality accident is deemed credible.

Although the HLW feed receipt tank will contain several times the critical mass of plutonium-239 (^{239}Pu), it is not expected that the safety criteria for engineered criticality controls and alarm systems will need to be invoked. BNFL has indicated that plutonium concentrations in the feed receipt tank and at other points in the process stream should be low; so low, in fact, that the minimum critical concentration for an infinite volume of waste optimally moderated with water will never be approached. Assuming the above statements hold true, the principle requirement imposed on operations for maintaining criticality safety in TWRS-P is feed sampling, which guarantees the fissile material content assumptions used in the criticality evaluation. Although feed sampling is not addressed explicitly by the criticality safety criteria, BNFL stated that it would be a process parameter control, as generally discussed in Safety Criterion 3.3-3. In response to Question 25, BNFL committed to sampling and analyzing the feed streams for fissile material content as a criticality safety control. Based on discussions with BNFL, the RU expected to find this information in Chapter 6; however, the reviewers found that the information provided lacked the detail and rigor to satisfy the Top-Level Standard for criticality.

The BNFL criticality subordinate standards do not state which process components will be evaluated for criticality. However, in response to Question 23, BNFL stated that the criticality assessment addresses all major process areas. Therefore, the response to Question23 commits BNFL to perform criticality calculations for all vessels and components where fissile material can accumulate in the facility. BNFL committed to provide information in Chapter 6 of the ISAR that would formally provide these calculations; however, the reviewers found that the information was not provided in the ISAR.

Therefore, the reviewers concluded that the BNFL treatment of criticality was incomplete and insufficient at this stage of conceptual design. The reviewers consider criticality safety to be an open issue that must be tracked and resolved early in Part B, prior to construction authorization.

Conclusions

The reviewers concluded the following:

- The standards selected by BNFL for the current design of electrical systems, components, and controls provide an adequate basis for implementing currently identified hazards control strategies. However, the reviewers noted that extensive changes to the existing control strategies and consequently the necessary standards and codes may be required as the design progresses to completion.

- The Contractor selected a set of standards for the fire safety program that is comprehensive and sufficient to achieve an adequate level of safety. The selected codes and standards reflect precedents established by the NRC and DOE.

- Because insufficient information was provided to support assumptions used to establish the BNFL safety case for criticality, the BNFL treatment of criticality was incomplete and insufficient in Part A. The reviewers consider criticality safety to be an open issue that must be tracked and resolved early in Part B, prior to construction authorization. The BNFL criticality safety criteria are sufficiently general and comprehensive to prevent criticality, provided they are implemented properly and specifically for the TWRS-P facility. The criticality safety criteria may require revision based on the outcome of Part B required analyses (i.e., safety criteria requiring double contingency or alarm systems may not be required if analysis shows that a criticality cannot occur). In response to Question 70, BNFL stated: "The current SRD criticality safety criteria are being retained until such time when either they may be required or dispensed with." Regardless of the outcome of the criticality evaluation, certain criticality safety criteria must remain in the SRD because they govern the criticality evaluation itself. The criticality safety criteria are commitments protecting the integrity of the presumed conclusion that criticality is not a concern (given the assumptions in the evaluation).

3.6.3 Compliance with Applicable Laws and Regulations

Results of the evaluation of standards set compliance with applicable laws and regulations is presented in Section 3.1 of this Evaluation Report. In summary, the reviewers concluded that the set of standards presented in the SRD complies with applicable laws and regulations.

3.6.4 Conformance to Top-level Standards and Principles

The evaluation of the conformance of the standards set to the top-level standards and principles in DOE/RL-96-0006, *Top-Level Radiological, Nuclear, and Process Safety Principles For TWRS Privatization Contractors*, is presented in Section 3.2 of this Evaluation Report. In summary, the reviewers identified a number of instances that the set of standards presented in the SRD does not conform to the top-level standards and principles in DOE/RL-96-0006. These are summarized in the Executive Summary and the details are in Section 3.2 of this Evaluation Report.

3.6.5 Standards Development Process

Evaluation of the standards development process is presented in Sections 3.4 and 3.5 of this evaluation report. Section 3.4 includes the assessment of whether the standards development process appropriately implements the standards process described in DOE/RL-96-0004. Section 3.5 describes the evaluation of whether the appropriate expertise was employed in the standards selection and confirmation processes. On the basis of these evaluations, the reviewers concluded that: (1) the standards set appropriately implements the standards process described in DOE/RL-96-0004, and (2) the standards set employs appropriate expertise in the standards selection and confirmation processes. Thus, the reviewers found the standards development process to be adequate.

3.6.6 Protection Against Unanticipated Hazards

The BNFL SRD, Vol. I, Section 3.6, "Maintenance of the SRD," describes the process to be employed by BNFL for ensuring that the SRD standards set is maintained consistent with the current facility design and operations. In addition, the BNFL ISMP, Section 4.1.1, "Development of Safety Management Process," discusses the maintenance of the SRD in the context of the development of safety management processes. The reviewers assessed the adequacy of safety management processes in ensuring that any unanticipated hazards will be identified and that appropriate standards-based controls will be developed for such hazards through evaluation of these two sections of the BNFL SA Package submittal, and the resolution of questions from the RU.[4]

BNFL committed to continual integration of hazards identification, SRD development, design development, and accident analysis during all phases of the facility life cycle through deactivation (see the BNFL ISMP, Section 4.1.1). In Section 3.6 of the SRD, Vol. I, BNFL committed to modify the safety criteria as necessary to reflect new information relating to the design and operation of the TWRS-P facility and the risk of facility operations during the period prior to submitting the revised SRD as part of the Construction Authorization Request. After issuance of the construction approval, but prior to issuance of the SRD Operating Authorization Request package, BNFL committed to controlling the SRD through the configuration management program.

The reviewers identified three issues during the evaluation of the adequacy of safety management processes in ensuring that any unanticipated hazards will be identified and that appropriate standards-based controls will be developed for such hazards. The first issue was the relationship between the BNFL change process for the SRD standards and the DOE-stipulated process in DOE/RL-96-0004. BNFL resolved this issue (Question 81) by committing to include, through the configuration management program, the essential elements of DOE/RL-96-0004 in its process for modifying standards as additional information relating to the design or hazards becomes available. The second issue was the definition of the circumstances in which RU review and approval was required for changes to standards in the SRD. BNFL resolved this issue (Questions 81, 169, and 177) by committing that no proposed change to the standards in the BNFL SRD, Vol. II, which

[4] Regulatory Unit questions 81, 169, 176, and 177 were developed to obtain additional information for the review related to this attribute.

could be interpreted as a decrease in commitment to worker or public safety, would be implemented without the review and approval of the RU. The third issue was the need for additional detail in the description of the configuration management process, which BNFL has committed to employ for making changes in the SRD. BNFL resolved this issue (Question 176) by providing additional information about (1) the organizations responsible for various configuration management activities, (2) the qualifications required for individuals performing configuration management functions, and (3) the criteria for acceptance or rejection of proposed changes.

Conclusions

The SRD, supplemented by the responses to questions, presents appropriate commitments and outlines a reasonable and logical approach for the following: (1) identifying unanticipated hazards as the design matures or the waste treatment processes or activities change, and (2) ensuring that appropriate standards-based controls will be selected for such hazards. Thus, the reviewers concluded that the BNFL safety management processes provide adequate assurance that any unanticipated hazards will be identified and that appropriate standards-based controls will be developed for such hazards.

4.0 Recommendations

4.1 Recommendation for Approval, Disapproval, or Conditional Approval

The reviewers recommend conditional approval of the SRD. The reviewers concluded that upon satisfying the conditions of Section 4.2 below, BNFL will have provided a standards set that, when properly implemented, will provide adequate safety, comply with all applicable laws and regulations and conform to the top-level safety standards and principles.

4.2 Conditions of Approval

The review team recommends that the RO approve the SRD subject to the following conditions.

Conditions Requiring Resolution As Part A Requirements (Prior to Commencement of Preliminary Design)

Inclusion of Requirements of All Applicable Laws and Regulations, Section 3.1

Compliance With All Other Applicable Regulations, Section 3.1.3

The SRD must be modified to clarify its usage of the term “tailored approach,” particularly with respect to 10 CFR 830, Sections 830.1 through 830.7

Conformance to Top-Level Standards and Principles, Section 3.2

Following the submittal and review of the SA Package and during the Regulatory Unit’s Review of the BNFL Initial Safety Analysis Report (ISAR), the RU questioned the Contractor’s safety approach in several areas; two of which were design classification and subordinate standards. As described in BNFL letter W338-98-0004 dated February 19, 1998, BNFL committed to changes that require significant revision to the SRD. The first change centered on the design classification approach used by BNFL. The second change centered on subordinate standards, as described in

BNFL letter 5193-98-0023 dated January 26, 1998. The majority of the following conditions for approval are required as a result of those changes.

Defense in Depth, Section 3.2.3.1.1

BNFL must modify the SRD so that SC 4.3-1 and SC 7.0-2 adequately incorporate Top-Level Principle 4.1.1.5, "Automatic Systems," and Top-Level Principle 4.1.1.3, "Control," respectively. These safety criteria must be modified to include all equipment important to safety instead of Design Class I and II, respectively. Additionally, BNFL must modify the SRD to include subordinate standards for all the safety criteria associated with defense in

BNFL letter W338-98-0004 dated February 19, 1998 and BNFL letter 5193-98-0023 dated January 26, 1998.

Safety Responsibility, Section 3.2.3.1.2

BNFL must modify the SRD such that safety criteria conform to Top-Level Principle 4.1.2.1, "Safety Responsibility." The proposed safety criteria (SC 7.0-1 and 7.1-3) have not clearly stated that BNFL Inc. has "ultimate responsibility for the safety of the facility." Additionally, BNFL must modify the SRD, as cited in BNFL letter 5193-98-0023 dated January 26, 1998, to include subordinate standards for all the safety criteria associated with the four Top-Level Principles of "Safety Responsibility."

Authorization Basis, Section 3.2.3.1.3

BNFL must modify the SRD, as cited in BNFL letter 5193-98-0023 dated January 26, 1998, to include subordinate standards for all the safety criteria associated with the Top-Level Principle of "Authorization Basis." The authorization basis subordinate standards must reflect the ISMP commitment to clarify the content of the authorization basis and to equate the authorization basis to the licensing basis referenced in the SRD and the ISMP.

Proven Engineering Practices and Margin, Section 3.2.3.2.2

BNFL must modify the SRD to adequately conform to the Top-Level Principles for "Proven Engineering Practices and Margins." Top-Level Principle 4.2.2.2, "Common-Mode/Common-Cause," and Top-Level Principle 4.2.2.3, "Safety System Design and Qualification," do not conform because all aspects of the principles were not addressed. For Top-Level Principle 4.2.2.2, Safety Criteria 4.1-3, 4.1-4 and 4.3-3 only address the effect of natural phenomenon and hazards and not all categories of potential hazards. The reviewers also noted that SC 4.1-3 and SC 4.1-4 establish seismic design criteria for which BNFL has not provided an adequate safety basis (see Section 3.3.1.3). Additionally, these safety criteria only addresses Design Class I and Design Class II SSCs, and not all SSCs "important to safety." With respect to Top-Level Principle 4.2.2.3, Safety Criterion only addresses Design Class I mechanical and electrical equipment instead of <u>all</u> SSCs "important to safety." Also, BNFL must modify the SRD to include adequate subordinate standards for Top-Level Principle 4.2.2.4, "Codes and Standards."

Inherent/Passive Safety Characteristics, Section 3.2.3.2.5

BNFL must modify the SRD to include adequate subordinate standards for Top-Level Principle 4.2.5.1 “Safety Margins Enhancement.”

Human Factors, Section 3.2.3.2.6

BNFL must modify the SRD to conform to Top-Level Principle 4.2.6, “Human Factors.” Safety Criterion 4.3-4 and Safety Criterion 4.3-6 do not adequately incorporate or conform to this principle because these criteria address only Design Class I and II equipment and not, as a minimum, all equipment “important to safety.”

Reliability, Availability, Maintainability, Inspectability (RAMI), Section 3.2.3.2.7

BNFL must modify the SRD to conform to Top-Level Principle 4.2.7.1, “Reliability.” The SRD did not provide a safety criterion or subordinate standards for this principle. Additionally, Safety Criterion 4.4-3 must be changed to apply to all SSCs “important to safety.”

Pre-Operational Testing, Section 3.2.3.2.8

BNFL must modify the SRD to conform to Top-Level Principle 4.2.8, “Pre-Operational Testing.” Of the four principles associated with “Pre-Operational Testing,” BNFL does not adequately conform to three. BNFL does not adequately conform to Top-Level Principle 4.2.8.1, “Testing Program,” Top-Level Principle 4.2.8.3, “Safety Systems Data,” and Top-Level Principle 4.2.8.4, “Design Operating Characteristics,” because the proposed safety criteria address only Design Class I and II SSCs, and not all SSCs important to safety. BNFL provided adequate ad hoc subordinate standards in the ISMP for the four principles; however, these standards must be incorporated by reference in the SRD.

Conduct of Operations, Section 3.2.3.3.1

BNFL must modify the SRD to conform to the “Conduct of Operations” Top-Level Principle. BNFL Safety Criteria did not adequately conform to the Top-Level Principle for “Conduct of Operation” for the following reasons. Safety Criterion 7.0-4 does not adequately address or incorporate the “full safety responsibility” aspect of Top-Level Principle 4.3.1.1, “Organizational Structure.” Safety Criteria 7.5-2, 7.2-2 and 7.2-4 do not adequately incorporate the “operator experience and qualifications and minimum requirements for the availability of staff or equipment” aspects of Top-Level Principle 4.3.1.4, “Readiness.” Safety Criterion 7.1-3 does not adequately address or incorporate the procedure aspect of Top-Level Principle 4.3.1.5, “Internal Surveillance and Audits.”

In addition, even though adequate ad hoc subordinate standards are described in the ISMP for the four principles, these standards must be incorporated by reference in the SRD.

Emergency Preparedness, Section 3.2.3.3.3

BNFL provided adequate ad hoc subordinate standards in the ISMP for the three principles of emergency preparedness; however, these standards must be incorporated by reference in the SRD.

Training and Qualification, Section 3.2.3.3.4

BNFL provided adequate ad hoc subordinate standards in the ISMP for the three principles of training and qualification; however, these standards must be incorporated by reference in the SRD.

Operational Testing, Inspection, and Maintenance, Section 3.2.3.3.5

BNFL must modify the SRD to conform Top-Level Principle 4.3.5.1, "Operational, Testing, Inspection and Maintenance." Safety Criteria 7.6-2 through 7.6-4 do not adequately conform because the safety criteria address only Design Class I and II SSCs and not all components "important to safety."

Internal Safety Oversight, Section 3.2.3.4

BNFL must modify the SRD to conform to Top-Level Principle 4.4, "Internal Safety Oversight." The BNFL SRD did not propose a standard or subordinate standard for Top-Level Principle 4.4.3, "Recommendation for Initiation of Construction," BNFL must also modify the SRD to include adequate subordinate standards for Top-Level Principle 4.4.2, "Qualified Personnel."

General Process Safety Overall Principles, Section 3.2.4.1

BNFL must modify the SRD to conform to Top-Level Principle 5.1, "General Process Safety Overall Principles." BNFL did not adequately incorporate or conform to Top-Level Principle 5.1.1, "Process Safety Management," because a safety criterion has not been proposed which clearly states that BNFL Inc. has "ultimate responsibility" for facility process safety. Additionally, BNFL must incorporate, by reference, applicable sections of the ISMP into the SRD as subordinate standards for all the safety criteria associated with "General Process Safety Overall Principles."

Process Safety Management Program, Section 3.2.4.2

BNFL must modify the SRD to conform to Top-Level Principle 5.2, "Process Safety Management Program." The BNFL SRD does not conform to Top-Level Principle 5.2.6, "Pre-startup Safety Review," because SC 6.0-5 does not require that the Contractor submit the results of their pre-startup reviews to the Director of the Regulatory Unit for evaluation and in support of authorization decisions and regulatory oversight. Additionally, the BNFL SRD must be modified to include subordinate standards for 9 of the 12 Top-Level Principles of "Process Safety Management Program." By reference, BNFL must incorporate applicable section of the ISMP in the SRD as subordinate standards.

Issues Requiring Resolution Prior to Construction Authorization

During the evaluation of the SRD, the reviewers identified a number of issues in which BNFL provided insufficient supporting information to reach a safety determination. A detailed description of these issues is found in the Section 3.3, “Assessment of Facility Hazards and Operations Hazards,” or Section3.6, “Safety Adequacy of the SRD.” These are issues that are commonly resolved during preliminary design, but essential to resolve prior to construction, since later resolution could result in adverse project cost and schedule impacts.

Assessment of Facility Hazards and Operations Hazards, Section 3.3

Nitric Acid and Resin Addition, Section 3.3.1.1.4

BNFL must finalize the hazards associated with disposition of the spent resin by incineration in the LAW melters (see Question 128).

Site Description, Section 3.3.1.3

BNFL must provide adequate justification to support their hazards approach for the natural phenomena hazards (NPH) design criteria described in the HAR (see Section 3.6.2.1, “General Design”).

BNFL must provide adequate justification to support the hazards approach used for their seismic design criteria. BNFL did not provide an adequate or sufficiently detailed safety basis to support the selection of a 0.24 vertical acceleration earthquake with a 2000-year return period.

Analysis of Facility Hazards, Section 3.3.2.3

BNFL must provide adequate justification to support their hazards approach for the hydrogen generation and potential explosions of flammable gases in process vessels in the waste receipt process area.

BNFL must provide adequate justification to support their hazards approach for criticality.

Safety Adequacy of SRD, Section 3.6

Adequacy of Process Control Strategies, Section 3.6.1.1

To assure adequate safety, BNFL must provide adequate safeguards (hazards control strategies) for water removal during cesium recovery, accidents involving HVAC filter machine crushing, and breaches of HVAC ductwork.

To assure adequate safety, BNFL must provide adequate safeguards (hazards control strategies) to prevent the accumulations of flammable gases in process vessels (i.e., the feed receipt tank and cesium storage tank).

Adequacy of Facility Hazards Control Strategies, Section 3.6.1.2

To assure adequate safety, BNFL must provide adequate safeguards (hazards control strategies) for “bulk chemical” hazards in the Wet Chemical Storage Building and Glass Formers Storage Building (see response to Question 34).

5.0 Acronyms

ALARA	as low as reasonably achievable
ASQC	American Society for Quality Control
BEIR	biological effects of ionizing radiation
BOD	Basis of Design
CFR	*Code of Federal Regulations*
CST	crystalline silicotitanate
D&D	decontamination and decommissioning
DC	Design Class
DEAR	DOE Acquisition Regulation
DF	decontamination factor
DOE	U.S. Department of Energy
DST	double-shell tank
DWPF	Defense Waste Processing Facility
ERPP	Environmental Radiation Protection Program
FSAR	Final Safety Analysis Report
HAE	hazard assessment experts
HAR	Hazard Analysis Report
HEME	High-efficiency mist eliminator
HEPA	high-efficiency particulate air (filter)
HLW	high-level waste
HP	Health Physics
HVAC	heating, ventilating, and air conditioning
ICRP	International Commission on Radiological Protection
IEEE	Institute of Electrical and Electronics Engineers
ISA	Integrated Safety Analysis
ISAR	Initial Safety Analysis Report
ISMP	Integrated Safety Management Plan
ISRT	Independent Safety Review Team
LANL	Los Alamos National Laboratory
LAW	low-activity waste
MT	metric tons
NCRP	National Council on Radiation Protection and Measurements
NFPA	National Fire Protection Agency
NPH	Natural Phenomena Hazard
NQA-1	Nuclear Quality Assurance (Standard for ANSI/ASME Nuclear Power Plants)

NRC	U.S. Nuclear Regulatory Commission
NUREG	U.S. Nuclear Regulatory Guide
OSHA	Occupational Safety and Health Administration
PFD	process flow diagram
PHA	Preliminary Hazards Analysis
PMT	Process Management Team
PSAR	Preliminary Safety Analysis Report
PUREX	plutonium uranium extraction
RAMI	reliability, availability, maintainability, inspectability
rem	Roentgen-equivalent man
RIT	Requirements Identification Team
RL	(DOE) Richland Operations Office
RO	Regulatory Official
RU	Regulatory Unit
S&S	safeguards and security
SA	Standards Approval
SAR	Safety Analysis Report
SC	safety criteria
SME	subject matter experts
SRD	Safety Requirements Document
SSC	systems, structures, and components
TRU	transuranic (waste)
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
TWRS-P	Tank Waste Remediation System privatization
UBC	Uniform Building Code
USQ	Unreviewed Safety Question
WAE	work activity experts
WVDP	West Valley Demonstration Project

6.0 References

10 CFR 60, “Preclosure Controlled Area,” *Code of Federal Regulation*, as amended.

10 CFR 70, “Domestic Licensing of Special Nuclear Material, *Code of Federal Regulation*, as amended.

10 CFR 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste,” *Code of Federal Regulation*, as amended.

10 CFR 100, “Reactor Site Criteria,” *Code of Federal Regulation*, as amended.

10 CFR 820, "Procedural Rules for DOE Nuclear Activities," *Code of Federal Regulation*, as amended.

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulation*, as amended.

10 CFR 834, "Radiation Protection of the Public and the Environment," *Code of Federal Regulation*, as amended.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulation*, as amended.

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Methods for the Assessment of Worker Safety Under Radiological Accident Conditions at Department of Energy Nuclear Facilities, EH-12-94-01.

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Safety Requirements Document, BNFL-5193-SRD-01, Rev. 0, BNFL Inc., Richland, Washington, September 26, 1997.

Top Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors, DOE/RL-96-0006, Rev. 0, U.S. Department of Energy, Richland Operations Office, Office of Radiological, Nuclear, and Process Safety Regulation, February 1996.

Top-Level Safeguards and Security Requirements for TWRS Privatization, DOE/RL-96-0002, Rev. 0, U.S. Department of Energy, Richland Operations Office, Office of Radiological, Nuclear, and Process Safety Regulation, February 1996.

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Appendix A

BNFL SA Package Docket Listing

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Appendix A

BNFL SA Package Docket Listing

Date	Docket No.	Title or Description	To Whom	From Whom
6/20/97	97-RU-B-041	Location of the Offsite Receptor for Accident Consequence Analysis	Gibbs, RU Director	Bullock, MJ
6/26/97	97-RU-B-042	Transmittal of the Guidance for the Review of the TWRS Privatization Contractors SRD and ISMP Submittal Packages [97-RU-0182/0183]	Bullock, MJ; General Manager BNFL	Gibbs/Barr
8/14/97	97-RU-B-048	Submittal of Safety Analysis Package of Contract Deliverables: DE-AC06-96RL13308	Gibbs	Smith, LW; BNFL
8/22/97	97-RU-B-049	Transmittal of "Guidance for Review of TWRS Privatization Contractor Radiation Exposure Standards for Workers"	Bullock	Gibbs/Barr
8/28/97	97-RU-B-050	Radiation Exposure Standard for Workers under Accident Conditions: Contract # DE-AC06-96RL13308	Gibbs/Rasmussen	Bullock/Smith
8/28/97	97-RU-B-051	Public Release of the Tank Waste Remediation Systems (TWRS) Privatization Contractor's Radiation Exposure Standard for Workers under Accident Conditions (BNFL-5193-RES-01): CONTRACT DE-AC06-96RL13308	Bullock, MJ; BNFL	Gibbs/Barr
9/22/97	97-RU-B-054	BNFL SAP Review Team Orientation	BNFL Review Team	Barr, Vanderniet, et. al.
9/22/97	97-RU-B-055	Standards Approval Submittal Package; BNFL; Contract # DE-AC06-96RL13308 [5193-97-0449-PM]	Gibbs/Rasmussen/Barr	Bullock/Smith; BNFL
9/25/97	97-RU-B-056	Designation of Rob Barr as Review Team Leader for the BNFL SAP Review	RU Staff/BNFL	Gibbs, DC
9/25/97	97-RU-B-096	Competition Sensitive/Proprietary Information Preliminary Technical Documents	Gibbs/Brown, Neil	Smith, LW; BNFL
9/29/97	97-RU-B-057	Public Release of the BNFL Standards Approval Package Submittal [97-RU-B-055]	Bullock, MJ; BNFL	Gibbs/Barr
10/1/97	97-RU-B-060	Response to Public Release of the TWRS Privatization Contractor's Radiation Exposure Standard for Workers Under Accident Conditions [BNFL-5193-RES-01]	Gibbs	Bullock, MJ; BNFL
10/3/97	97-RU-B-061	Acceptance for Review of the BNFL Standard Approval Package: DE-AC06-RL13308	Bullock, MJ; BNFL	Gibbs/Barr

Date	Docket No.	Title or Description	To Whom	From Whom
10/3/97	97-RU-B-064	Response to Regulatory Unit's Questions on the Standards Approval Package [97-RU-B-055]	Gibbs/Barr	Bullock, MJ; BNFL
10/6/97	97-RU-B-063	Release of the RESW and SAP	Bullock, MJ; BNFL	Barr
10/6/97	97-RU-B-065	Completion of Standards Approval Package Submittals [Environmental Report]	Rasmussen/Gibbs/Barr	Bullock, MJ; BNFL
10/15/97	97-RU-B-066	Change in Process for Release of Competition Sensitive Information	Bullock, MJ; BNFL	Gibbs/Miller
10/16/97	97-RU-B-068	Proposed Revision to Hazard Analysis Report Section 6.0 [97-RU-B-055]	Gibbs/Rasmussen	Bullock/Smith
10/17/97	97-RU-B-067	First Set of Preliminary Questions to the BNFL, Inc. Standards Approval Package [97-RU-B-055]	Bullock, MJ; BNFL	Gibbs/Barr
10/17/97	97-RU-B-069	NRC Comments on BNFL, Inc. SAP [97-RU-B-055]	Gibbs, DC	Pierson, RC; Chief, Spec. Projects, NRC
10/22/97	97-RU-B-070	BNFL Presentation to RU; Standards Approval Package	Barr	Smith, LA; BNFL
10/23/97	97-RU-B-071	Response to RU letter 97-RU-0307, "Acceptance for Review the BNFL Standards Approval Package" [97-RU-B-055]	Gibbs/Barr	Bullock, MJ; BNFL
10/24/97	97-RU-B-072	Second Set of Preliminary Questions to the BNFL, Inc. Standards Approval Package [97-RU-B-055]	Bullock, MJ; BNFL	Gibbs/Barr/Vanderniet
10/30/97	97-RU-B-075	Additional NRC Comments on BNFL Standards Approval Package	Gibbs/Barr	Pierson, RC; NRC
10/31/97	97-RU-B-074	Third Set of Preliminary Questions to the BNFL, Inc Standards Approval Package [97-RU-B-055]	Bullock	Gibbs/Barr
11/11/97	97-RU-B-077	BNFL Inc. Response to RU Questions on the Standards Approval Package [97-RU-B-055]	Gibbs/Barr	Smith, LW; BNFL
11/24/97	97-RU-B-078	RU Position on Contractor Initiated Changes to the Authorization Basis, Including Changes to the SRD	Bullock, MJ; BNFL	Gibbs/Barr/Carier/ Smoter
11/26/97	97-RU-B-079	Transmittal of RU's Review Team's Disposition to BNFL, Inc. Responses to Review Team's Questions: Contract DE-AC06-RL13308	Bullock, MJ; BNFL	Gibbs/Barr
11/26/97	97-RU-B-080	RU Guidance for the Review of the Initial Safety Assessment: Part I-Phase A TWRS-P Contract Deliverable [Response to 97-RU-B-076]	Bullock, MJ; BNFL	Gibbs/Barr/Hawkins

Date	Docket No.	Title or Description	To Whom	From Whom
12/4/97	97-RU-B-082	RU Disposition of NRC Comments on the BNFL, Inc. Standards Approval Package Submittal [97-RU-B-055]	NRC (Pierson, RC)	Gibbs, DC
12/8/97	97-RU-B-083	BNFL, Response to the RU disposition on the Standards Approval Package [97-RU-B-055]	Gibbs/Barr	Smith, LW; BNFL
12/8/97	97-RU-B-084	NRC Questions on the BNFL, Inc. SAP [97-RU-B-055]	Bullock, MJ; BNFL	Gibbs/Barr
12/12/97	97-RU-B-088	Supplementary Response to Question #152 - Development of an PRP governing DOE Activities; BNFL Memorandum	Bocanegra	Edwards, Don; BNFL
12/15/97	97-RU-B-093	Supplementary Response to Question #152 - Development of an PRP governing DOE Activities; BNFL Memorandum -- 2nd version	Bocanegra	Edwards, DW; Licensing, Permitting & Safety, BNFL
12/17/97	97-RU-B-090	BNFL Inc. Final Closeout Disposition of Questions on the SAP [97-RU-B-055]	Gibbs	Edwards, DW; Licensing, Permitting & Safety, BNFL
12/17/97	97-RU-B-092	BNFL, Inc. Final Closeout Disposition of Questions on the SAP (Correction) [97-RU-B-055]	Gibbs/Barr	Edwards, DW; Licensing, Permitting & Safety, BNFL
1/13/98	98-RU-B-002	Transmittal of RU Review Teams Disposition to BNFL's Supplemental Responses to Review Team Questions	Bullock, MJ; BNFL	Gibbs/Barr
1/14/98	98-RU-B-003	Evaluation of BNFL, Inc. Proprietary Designation of the Standards Approval Package	Bullock, MJ; BNFL	Gibbs/Barr
1/22/98	98-RU-B-008	Trip Report: Observations	Sharp, Genny; IACO	Barr, RC
1/21/98	98-RU-B-011	Re-designation of BNFL Inc. Proprietary Designation of Contract Deliverables [approval to remove competition sensitive markings from SAP]	Gibbs, DC	Bullock/Smith; BNFL

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Appendix B

Evaluation Report

BNFL Inc. Radiation Exposure Standard for Workers Under Accident Conditions

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Appendix B

Evaluation Report

BNFL Inc. Radiation Exposure Standard for Workers Under Accident Conditions

1.0 Requirements

To manage the radiological and nuclear safety risks associated with the proposed Tank Waste Remediation System privatization (TWRS-P) facility, the DOE regulatory approval process requires that the Contractor's set of selected standards conform to those specified in the *Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors* (DOE/RL-96-0006).[1] These standards limit the risk to facility workers (workers), other Hanford site workers (co-located workers), members of the general public (public), and the environment from the radiological consequences of normal operations and credible accident events. These standards are established in DOE/RL-96-0006, Sections 2.0, "Radiological and Nuclear Safety Standards," and 3.0, "Radiological and Nuclear Safety Objectives." Section 2.1 of DOE/RL-96-0006, "Individual," includes Table 1, *Dose Standards Above Normal Background*.

The Contractor (BNFL Inc.) has specifically addressed radiological and nuclear safety standards in the regulatory submittal, *Radiation Exposure Standard for Workers Under Accident Conditions* (RESW). The scope of BNFL's RESW addresses more than that implied by the title. Table 1 of DOE/RL-96-0006 specifies conformance to both radiological dose and ALARA design standards. The table addresses workers, co-located workers and the public and it addresses normal operations as well as credible accident conditions. The standards proposed by the Contractor in its RESW are also required to comply with all applicable laws and regulations and provide for adequate safety.

1.1 Radiological and Nuclear Safety Standards

BNFL's RESW is required to conform to three types of top-level standards as specified by DOE in Table 1 of Section 2.1, "Individual," DOE/RL-96-0006. The first type, applicable to workers and co-located workers, is a radiation dose standard (in units of rem/y or rem/event) addressing external and internal whole body, partial body and organ exposures. The second type, applicable to the public, is a radiation dose standard expressed as a total effective dose equivalent (both internal and external) or effective dose equivalent to the thyroid, in units of rem/y or rem/event from a specific pathway or source. The third type of standard, applicable to workers and co-located workers, is termed an As Low as Reasonable Achievable (ALARA) design limit in units of rem/y or rem/event.

The first and second standards concern radiation dose. DOE/RL-96-0006, Table 1, specifies four event probability ranges addressing normal operation and credible accident conditions. General

[1] *Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors*, DOE/RL-96-0006, Revision 0, February 1996.

guidelines and frequencies, listed for the four event probability ranges, are:

1. Normal events are typical of normal facility operations expected to occur regularly in the course of facility operations; the associated frequency of occurrence during the lifetime of the facility is 1 or more per year. As defined in Table 1, a general guideline for this event probability is that normal modes of operating the facility systems should provide adequate protection of health and safety.

2. Anticipated events are characterized as minor incidents and upsets of moderate frequency that may occur once or more during the lifetime of the facility; the associated probability range is 10^{-2} to less than one per year. As defined in Table 1, a general guideline for this event probability range is that the facility should be capable of returning to operation without extensive corrective action or repair.

3. Unlikely events are characterized as more severe incidents that are not expected, but may occur, during the lifetime of the facility; the associated probability range is 10^{-4} to 10^{-2} per year. As defined in Table 1, a general guideline for this event probability range is that the facility should be capable of returning to operation following potentially extensive corrective action or repair, as necessary.

4. Extremely unlikely events are characterized as events that are not expected to occur during the lifetime of the facility, but are postulated because their consequences would include the potential for the release of significant amounts of radioactive material; the associated probability range is 10^{-6} to 10^{-4} per year. As defined in Table 1, a general guideline for this event probability range is that facility damage may preclude returning to operation. (Note that a probability of occurrence of 10^{-2} per year is equivalent to a frequency of one occurrence in 100 years; 10^{-4} per year equates to one in 10,000 years; 10^{-6} per year equates to one in 1,000,000 years.)

DOE/RL-96-0006, Table 1, requires that the Contractor derive standards for both the worker and the co-located worker at the accident probability ranges of unlikely events and extremely unlikely events. A footnote to the four “To be derived” entries in Table 1 states that specific limits are to be derived and proposed by the Contractor and that examples of such derived limits and implementation approaches are described in the DOE/EH report *Methods for the Assessment of Worker Safety Under Radiological Accident Conditions at Department of Energy Nuclear Facilities*.[2] The footnote to Table 1 also states that the specific limits (standards) will be finalized as part of the standards identification and approval activities to be performed early in Part A of the program.

The ALARA design standard listed in DOE/RL-96-0006, Table 1, is consistent with ALARA design objectives used to evaluate engineering features under normal operations as presented in 10 CFR Part 835, “*Occupational Radiation Protection*.” The design objective establishes an exposure level value, in units of mrem per hour, to control the potential exposure of a radiological worker. In general terms, the facility shall be designed to maintain radiological workers at 20 percent of the applicable standards and as far below this average as is reasonably achievable.

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[2] *Methods for the Assessment of Worker Safety Under Radiological Accident Conditions at Department of Energy Nuclear Facilities*, EH-12-94-01, June 1994.

For anticipated events, the design standard is not a dose limit but rather the specification of a process that has the objective of optimizing the selection of safety systems, structures, components, and administrative controls (safeguards) during the design phase. The ALARA design limit standard specifies the event consequence as a radiation dose value, above which the documented ALARA design-engineering program must be applied to evaluate potential safeguards affecting the event sequence. From a design perspective, this value represents a threshold level for the consequence of a normal operation or an accident above which an ALARA evaluation would be performed to determine whether a potential engineering feature would be optimal given economical and societal considerations. If a potential engineering feature were determined to be cost-effective and feasible, it would be incorporated in the facility design.

1.2 Radiological and Nuclear Safety Objectives

The standards proposed by BNFL in its RESW also address the four top-level safety objectives presented in DOE/RL-96-0006, Section 3. Three of the objectives are the Operations Risk Goal, the Accident Risk Goal, and the Worker Accident Risk Goal, which are presented as General Safety Objectives (Section 3.1). The fourth objective is presented as the Radiation Protection Objective (Section 3.2).

The Operations Risk Goal (DOE/RL-96-0006, Section 3.1.1) states that: "The risk, to the population (public and workers) in the area of the Contractor's facility, of cancer fatalities that might result from facility operation should not exceed one-tenth of one percent (0.1%) of the sum of cancer fatality risks to which members of the U.S. population generally are exposed." A referenced footnote in DOE/RL-96-0006 states that: "For evaluation purposes, individuals are assumed to be located within 10 miles of the controlled area."

The Accident Risk Goal (DOE/RL-96-0006, Section 3.1.2) states that: "The risk, to an average individual in the vicinity of the Contractor's facility, of prompt fatalities that might result from an accident should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population generally are exposed." A referenced footnote in DOE/RL-96-0006 states that: "For evaluation purposes, individuals are assumed to be located within one mile of the controlled area."

The Worker Accident Risk Goal (DOE/RL-96-0006, Section 3.1.3) states that: "The risk, to workers in the vicinity of the Contractor's facility, of fatality from radiological exposure that might result from an accident should not be a significant contributor to the overall occupational risk of fatality to workers." A referenced footnote in DOE/RL-96-0006 states that: "For evaluation purposes, workers are assumed to be located within the controlled area."

The Radiation Protection Objective (DOE/RL-96-0006, Section 3.2) is to "Ensure that during normal operation radiation exposure within the facility and radiation exposure and environmental impact due to any release of radioactive material from the facility is kept as low as is reasonably achievable (ALARA) and within prescribed limits, and ensure mitigation of the extent of radiation exposure and environmental impact due to accidents."

2.0 Review Methodology

This evaluation report documents the results of the review and evaluation performed by the DOE Regulatory Unit (RU) review team of the BNFL regulatory deliverable, *Radiation Exposure*

Standard for Workers Under Accident Conditions (RESW). The deliverable is contained in BNFL's report, *Radiological and Nuclear Exposure Standards for Facility and Co-located Workers*, BNFL-5193-RES-01.[3] Revisions to the deliverable were provided on December 8 and 17, 1997, as part of the RU review team question and comment resolution process.

2.1 Review Criteria and Reference Documents

The BNFL RESW submittal is a portion of its recommended set of radiological, nuclear, and process safety standards documented in its Safety Requirements Document (SRD), BNFL-5193-SRD-01, Volumes I and II. Approval of the RESW is based on criteria presented in the *DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors* (DOE/RL-96-0003).[4] Applicable topics, and the associated criteria, which are contained in Section 3.3.1, "Standards Approval," of DOE/RL-96-0003, are as follows:[5]

> **Compliance with Applicable Laws and Regulations. T**he set documented in the SRD includes all requirements of applicable laws and regulations; in particular 10 CFR 835, *Occupational Radiation Protection*.
>
> **Conformance with Top-Level Standards.** The set documented in the SRD conforms to the top-level radiological, nuclear, and process safety standards and principles contained in the DOE-provided DOE/RL-96-0006.
>
> **Provisions for Adequate Safety.** The set documented in the SRD will provide adequate safety if properly implemented.

This review conformed with the methodology for review of the BNFL Standards Approval Package (SAP) submittal contained in *Guidance to the Reviewer of TWRS Privatization Contractor Safety Requirements Document Submittal Package*.[6] The reviewers used guidance provided in *Guidance for Review of TWRS Privatization Contractor Radiation Exposure Standards for Workers*.[7] Other documents referred to during this review are as follows:

> 10 CFR 20, "Standards for Protection Against Radiation," Final Rule, as amended.
>
> 10 CFR 60.136, "Preclosure Controlled Area," Draft Rule.

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[3] *Radiological and Nuclear Exposure Standards for Facility and Co-located Workers*, BNFL-5193-RES-01, Rev. 0, August 28, 1997.

[4] *DOE Regulatory Process for Radiological, Nuclear, and Process Safety for TWRS Privatization Contractors,* DOE/RL-96-0003, Revision 0, February 1996.

[5] Ibid., Section 3.3.1, items 1, 2, and 6. p. 4 of 35.

[6] *Guidance to the Reviewer of TWRS Privatization Contractor Safety Requirements Document Submittal Package,* RL/REG-97-08, Rev. 0, June 1997.

[7] *Guidance for Review of TWRS Privatization Contractor Radiation Exposure Standards for Workers,* RL/REG-97-09, Rev. 0, July 1997.

10 CFR 70, “Domestic Licensing of Special Nuclear Material,” Final Rule, as amended.

10 CFR 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste,” Final Rule, as amended.

10 CFR 100, “Reactor Site Criteria,” Final Rule, as amended.

10 CFR 834, “Radiation Protection of the Public and the Environment,” Draft Rule.

10 CFR 835, “Occupational Radiation Protection,” Final Rule.

DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, 1994.

EH-12-94-01, *Method for the Assessment of Worker Safety under Radiological Accident Conditions at Department of Energy Nuclear Facilities*, Vol. 1, Main Report, and Vol. 2, Appendixes, 1994.

ICRP Publication 55, *Optimization and Decision-Making in Radiological Protection*, September 1988.

Letter, Scott, Walter B., RL, to Contractors, “Clarification of Hanford Site Boundaries for Current and Future Use in Safety Analysis,” 1995.

Letter, Sellers, Elizabeth D., RL, to Fluor Daniel Hanford, Inc., “Risk Evaluation Guidelines (REGs) to Ensure Inherently Safe Designs,” 1997.

NBS Handbook 69, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for Occupational Exposure*, 1963.

SEN-35-91, *Nuclear Safety Policy*, Secretary of Energy Notice, 1991.

Westinghouse GOCO Radiological Engineering Guide, Westinghouse Electric Corporation, November 1996.

2.2 Consideration of DOE and NRC Approaches to Radiological and Nuclear Safety

Differences exist between the TWRS privatization contract requirements and NRC regulations with respect to the determination of radiation doses from accidents to individuals outside of the owner-controlled area. This report section describes and evaluates the differences in these doses based on the RU’s understanding of NRC regulations.

A significant difference is that the contract classifies individuals located outside the contractor-leased property as co-located workers if they are located within the Hanford Site boundary, and all other individuals as members of the public. This classification is consistent with current practices and nomenclature used at Hanford and other DOE sites. NRC regulations do not include provisions for individuals to be classified as co-located workers. Furthermore, under the NRC regulation 10 CFR 100, postulated accident doses to individuals in close proximity to the facility are calculated based on a 2-hour duration of exposure from the accident, which takes credit for prompt evacuation.

The radiological and nuclear safety standards specified by Table 1 of DOE/RL-96-0006 are consistent with facility siting and design concepts and methods used previously by DOE contractors for facilities within the DOE complex. These methods are documented in DOE report EH-12-94-01, *Methods for the Assessment of Worker Safety under Radiological Accident Conditions at Department of Energy Nuclear Facilities*, Volumes 1 and 2. The dose standards specified in the Table 1 are consistent with risk Evaluation Guidelines (EGs), which is a term defined in DOE safety documents (e.g. DOE-STD-3009-94 and EH-12-94-01). In designing a nuclear facility using these standards, the risk (probability x consequences) associated with various events postulated in the accident analysis is compared to a set of risk EGs. The primary purpose for using the EGs is to establish a threshold above which there is a need to identify safety structures, systems, and components required to protect workers, co-located workers, and the public. The RESW radiation dose standards and ALARA design standards are consistent with the risk EG-type approach.

Currently, the NRC has not promulgated rules for regulating radioactive waste vitrification facilities. Although it is possible that the NRC could regulate the vitrification facilities under 10 CFR 70, “Domestic Licensing of Special Nuclear Material,” no policy or decision has been made to do so as of this evaluation.

Three current NRC regulations address accident dose limits related to facility siting and design. Relevant aspects of these regulations are discussed below.

NRC regulation 10 CFR 60 “Disposal of High-level Radioactive Wastes in Geologic Repositories,” specifies design requirements for geologic repository operations areas. Part 60.136, “Preclosure controlled area” requires that the repository’s preclosure operations area be designed such that doses to individuals from design basis events will be limited to 5 rem total effective dose equivalent at or beyond the preclosure controlled area boundary. The regulation also specifies organ, tissue, and eye lens dose limits, and sets a minimum distance of 100 meters from surface facilities in the operations area to the preclosure controlled area boundary.

For facilities, licensed by the NRC under 10 CFR 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste,” and 10 CFR 50, “Domestic Licensing of Production and Utilization Facilities,” regulations require determination of the doses to the public resulting from accident scenarios. NRC regulations may also specify significant accident prevention or consequence mitigation systems, such as a containment structure, depending on the nature of the facility. Therefore, under these NRC regulations, protection of the worker under accident conditions is achieved by specifying required safeguards and ensuring conformance to dose limits for the public under these accident scenarios.

NRC regulation 10 CFR 72 covers reactor spent fuel storage requirements and 10 CFR 100 covers facility siting criteria for nuclear facilities licensed under 10 CFR 50. Each of these regulations specifies a maximum radiation dose to a member of the public during accident conditions. Applicable criteria found in 10 CFR 72.106 limit the dose to an individual at the controlled area boundary, from any design basis accident, to 5 rem total effective dose equivalent and 5 rem to any organ. The controlled area boundary is defined in this regulation to mean the area surrounding the facility over which “the licensee exercises authority over its use…” This definition is different than the TWRS-P contract definition of controlled area which means the area surrounding the facility enclosed by a common perimeter fence, which the contractor exercises authority over, and may include all or part of the contractor leased land.

Applicable criteria found in 10 CFR 50.34 and 10 CFR 100.11 require that Part 50 licensees define an exclusion area of such size that the radiation dose from an accident to a member of the public is less than or equal to 25 rem total effective dose equivalent, based on a 2-hour duration of exposure. Additionally, the regulations require that a licensee define a low population zone (LPZ) of such size that the radiation dose from an accident to a member of the public is less than or equal to 25 rem total effective dose equivalent, based on exposure for the duration of the exposure. The reviewers noted that the Washington Nuclear Project No. 2 plant located adjacent to Hanford Site has an exclusion zone that extends 1.2 miles from the plant and an LPZ extending 3 miles from the plant as documented in the Final Safety Analysis Report.[8]

The reviewers did not attempt to correlate the contractor's RESW radiation dose standards with the accident dose values in 10 CFR 60.136, 10 CFR 100.11, or 10 CFR 72.106. The reviewers concluded that making such a comparison of dose values was not meaningful or useful because of the significant differences in definitions and application of the accident dose limits.

3.0 Evaluation

The standards proposed in the BNFL RESW were reviewed in accordance with the criteria contained in DOE/RL-96-0003 for (1) appropriate inclusion of and compliance to applicable laws and regulations; (2) conformance to the top-level radiological, nuclear, and process safety standards and principles contained in DOE/RL-96-0006; and (3) provisions affording adequate safety, if properly implemented. The review of the BNFL RESW included several exchanges of questions from the RU and responses from BNFL. Among the issues addressed were the standards proposed by BNFL in Table A, "*Exposure Standards Above Normal Background*."[9] Table A provides the BNFL proposed standards corresponding to those required by Table 1 of DOE/RL-96-0006. BNFL on December 8 and 17, 1997 provided revisions to the text of the RESW and Table A including footnotes.

RU Questions 158 and 159, and the associated BNFL responses, addressed and resolved the issue of whether the BNFL proposed standards conformed to DOE-specified ALARA design limits for workers and co-located workers under normal and anticipated events. The BNFL responses provided additional justification ensuring that the BNFL-proposed standards would meet these design objectives. RU Question 159 also addressed whether the BNFL-proposed standards for the "To be derived" entries listed in Table 1 conformed with DOE/RL-96-0006 for workers and co-located workers under unlikely and extremely unlikely events. While not explicitly required by the "To be derived" entries listed in Table 1, the RU review team evaluated the proposed standards to determine whether cost-effective and feasible safeguards would be evaluated by the Contractor for accidents under these event ranges to ensure adequate safety. In response to Question 159, BNFL

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[8] Washington Public Power Supply System, "Final Safety Analysis Report," Washington Nuclear Power Plant Unit No.2, Docket No. 50-937, March 17, 1980

[9] BNFL-5193-RES-01, Rev. 0, September 1997.

provided additional justification ensuring that its listed standards for the “To be derived” entries conformed to the General Safety Objectives in DOE/RL-96-0006.

3.1 Compliance to Applicable Laws and Regulations

The radiation dose standards proposed in the BNFL RESW comply with applicable laws and regulations, including those governing radiation dose limits for workers and the public under normal events. It is noted that the radiation dose standards for a co-located worker of 5 rem per year under normal events (and 5 rem per event under anticipated events), that are specified by DOE in Table 1 of DOE/RL-96-0006, include all contributors to the occupational exposure of a co-located worker. That is, the regulatory occupational dose limit for a co-located worker is 5 rem from all occupational exposures. The 5 rem dose limit for a co-located worker in Table 1 is not intended to authorize an additional 5 rem from BNFL facility operations for a co-located worker at a nearby facility. Without such notation, these standards would not be in compliance with 10 CFR 835, *Occupational Radiation Protection*.

3.2 Conformance to the Radiological and Nuclear Safety Standards

The radiological and nuclear safety standards established by DOE as top-level standards for an individual are listed in Table 1 of DOE/RL-96-0006. BNFL has proposed standards for a worker, co-located worker, and a member of the public under normal events, anticipated events, unlikely events, and extremely unlikely events in Table A of its RESW. The review and evaluation of these standards is presented according to the event probability range. In many cases, BNFL has proposed standards that tailor several of the top-level standards presented in DOE/RL-96-0006. Conformance of the proposed standards to those specified by DOE has been evaluated by considering the objective of each DOE standard and the justifications provided by BNFL in its RESW or in its responses to applicable RU questions.

3.2.1 Normal Events

Under normal events, the standards proposed by BNFL in Table A of its RESW have tailored the DOE-specified Table 1 top-level standards with respect to the probability range of normal events and the specification of an ALARA design limit. In Table A, BNFL redefines the normal (and anticipated) event probability range such that minor incidents and upsets having an associated frequency greater than 10^{-1} per year have been included in the normal events range rather than in the anticipated events range. Considering the expected operating lifetime of the proposed facility, this redefinition of the probability range of normal events is reasonable and likely will provide for a more conservative and appropriate application of dose standards than that specified by Table 1. For these reasons, the BNFL tailored top-level standards adequately conform to the DOE-specified Table 1 top-level standards with respect to the designated event probability ranges.

The radiation dose standards proposed in by BNFL Table A for a worker, co-located worker and a member of the public under normal events are equivalent to those specified by DOE in Table 1 of DOE/RL-96-0006. The reviewers noted that the dose standard for the public from the airborne pathway is limited to less than or equal to 10 mrem per year from all applicable sources on the Hanford site, which would include the proposed BNFL facility.

In its RESW Table A, the BNFL submittal proposes a tailored ALARA design limits standard for the redefined normal event probability range (10^{-1} per year to > 1 per year) for both a worker and a co-located worker. In each case, the top-level standard for the ALARA design limit is listed in Table 1 of DOE/RL-96-0006 as ≤1.0 rem/y. Table A proposes the same design limit, ≤1.0 rem/y, but qualifies it as "per 10 CFR 835 design objective and per 10 CFR 835.1002(b)," and adds a footnote stating: "In addition to meeting the listed design objective of 10 CRF 835.1002(b), the inhalation of radioactive material by workers and co-located workers under normal conditions is kept ALARA through the control of airborne radioactivity as described in 10 CFR 835.1002(c)."

The proposed standards are equivalent to the applicable top-level ALARA design limit standards and therefore conform. They also provide for an adequate level of safety and ensure that cost-effective safeguards affecting normal events are evaluated (and incorporated as appropriate) in accordance with the ALARA design objectives of the applicable regulation 10 CFR 835. As resolved through RU Question 158, the proposed standard addresses the control of both external and internal (from inhalation) radiation exposures.

These proposed standards adequately conform to the DOE-specified top-level standards for radiation dose and the ALARA design limit, as applicable, under normal events.

3.2.2 Anticipated Events

The radiation dose standards selected by BNFL in Table A of its RESW for a worker, co-located worker, and a member of the public under anticipated events are equivalent to those specified by DOE in Table 1 of DOE/RL-96-0006.

In Table A of its RESW, BNFL proposes a tailored ALARA design limit standard for the redefined anticipated event probability range (10^{-2} to 10^{-1} per year), for both a worker and a co-located worker. The top-level standard is listed in Table 1 of DOE/RL-96-0006 as an ALARA design limit of ≤1.0 rem/event. Table A proposes 1.0 rem/event Design Action Threshold with a footnote stating that "When a calculated accident exposure exceeds this threshold, then appropriate actions are taken. These include carrying out a less bounding (i.e., more realistic) evaluation to show that the accident consequences will be below the threshold or evaluating additional safeguards for cost-effectiveness and/or feasibility. This threshold is not a limit; it does not require the implementation of additional preventive or mitigative features if they are not both cost-effective and feasible." The term "less bounding" is noted by the RU review team to imply that the evaluation would be reassessed using less conservative, but realistic, values. The proposed standards are equivalent to the applicable top-level standards and therefore conform. The proposed standards also provide for an adequate level of safety and ensure that cost-effective safeguards affecting anticipated events are evaluated (and incorporated as appropriate) whenever the final calculated event consequence to a worker or co-located worker is 1 rem or more.

These proposed standards adequately conform to the DOE-specified top-level standards for radiation dose and the ALARA design limit, as applicable, under anticipated events.

3.2.3 Unlikely Events

In Table A of its RESW, BNFL proposes a ≤25 rem/event radiation dose standard with two footnotes stating that:

1. "In addition to meeting the listed worker and co-located worker dose standards for accidents, the Worker Accident Risk Goal is satisfied through the calculation of the

risk from accidents with accident prevention and mitigation features added as necessary to meet the Goal. (See Section 2.0 of BNFL-5193-RES-01); and

2. "In addition to meeting the listed dose standards for accidents, BNFL's approach to accident mitigation is to evaluate accident consequences to ensure that the calculated exposures are far enough below standards to account for uncertainties in the analysis, and to provide for sufficient design margin and operational flexibility."

The proposed 25 rem per event dose standard as a consequence of an accident is low enough to ensure that the risk to workers and co-located workers from the consequences of accidents would be acceptable.

The radiation dose standard proposed by BNFL in Table A of its RESW for a member of the public under the unlikely events range is the same as that specified by DOE in Table 1 of DOE/RL-96-0006. The standard is ≤5 rem per event.

BNFL's overall approach to accident mitigation and selection of safeguards would provide an adequate level of safety and its proposed consequence limit is sufficiently low to ensure that radiation exposures to individuals as a result of accidents in the unlikely events range would be ALARA. The proposed standards conform to the applicable top-level standards. They also provide for an adequate level of safety and ensure that cost-effective safeguards affecting unlikely events will be evaluated (and incorporated as appropriate) consistent with the optimization approach embodied by the ALARA principle.

3.2.4 Extremely Unlikely Events

In Table A of its RESW, BNFL proposes a ≤25 rem per event radiation dose standard for a worker and co-located worker under extremely unlikely events. The entries are accompanied by two footnotes stating that:

1. "In addition to meeting the listed worker and co-located worker dose standards for accidents, the Worker Accident Risk Goal is satisfied through the calculation of the risk from accidents with accident prevention and mitigation features added as necessary to meet the Goal. (See Section 2.0 of BNFL-5193-RES-01); and

2. In addition to meeting the listed dose standards for accidents, BNFL's approach to accident mitigation is to evaluate accident consequences to ensure that the calculated exposures are far enough below standards to account for uncertainties in the analysis, and to provide for sufficient design margin and operational flexibility."

The proposed 25 rem per event dose standard as a consequence of an accident is low enough to ensure that the risk to workers and co-located workers from the consequences of accidents would be acceptable.

The radiation dose standards proposed by BNFL in Table A of its RESW for a member of the public under the extremely unlikely events range is more restrictive than those specified by DOE in Table 1 of DOE/RL-96-0006. In addition to the standards specified by DOE of ≤25 rem per event and ≤300 rem per event to the thyroid, BNFL has set a standard of ≤5 rem per event target. The reviewers interpreted the standards to mean that the BNFL design standards and approach to safety would result in the facility conforming to the ≤ 25 rem per event and ≤ 300 rem per event to the thyroid standards and would be based on a target of the facility conforming to a less than or equal to 5 rem per event standard.

BNFL's overall approach to accident mitigation and selection of safeguards provides an adequate level of safety, and its proposed consequence limit is sufficiently low to ensure that radiation exposures to individuals as a result of accidents in the extremely unlikely events range would be ALARA. The proposed standards conform to the applicable top-level standards. They also provide for an adequate level of safety, and ensure that cost-effective safeguards affecting extremely unlikely events are evaluated (and incorporated as appropriate) consistent with the optimization approach embodied by the ALARA principle.

3.3 Conformance to the General Safety Objectives

Standards proposed in the BNFL RESW provide for conformance, in part, to the General Safety Objectives specified in DOE/RL-96-0006, which are the Operations Risk Goal, Accident Risk Goal and Worker Accident Risk Goal. In each case, other standards selected by BNFL (and documented in its SRD[10]) that are related to the General Safety Objectives have been reviewed and are discussed as necessary to evaluate conformance.

3.3.1 Conformance to the Operations Risk Goal

The Operations Risk Goal (DOE/RL-96-0006, Section 3.1.1) states that: "The risk, to the population (public and workers) in the area of the Contractor's facility, of cancer fatalities that might result from facility operation should not exceed one-tenth of one percent (0.1%) of the sum of cancer fatality risks to which members of the U.S. population generally are exposed."
A referenced footnote in DOE/RL-96-0006 states that: "For evaluation purposes, individuals are assumed to be located within 10 miles of the controlled area."

Conformance with the Operations Risk Goal was evaluated for facility operations limited to normal events and accident dose assessments consistent with Table 1 of DOE/RL-96-0006. Data are available on the annual and ten-year average cancer fatality risks to the U.S. population[11] to evaluate conformance with this goal. The ten-year cancer fatality average for the U.S. population is 173 cancer fatalities per 100,000 persons (1982-1992). In 1996, the annual cancer fatality average for the U.S. population is 210 cancer fatalities per 100,000 persons. These data approximate to 200 cancer fatalities per 100,000 persons per year. Using these data, the corresponding one-tenth of one percent value specified in the goal was 0.2 cancer fatalities per 100,000 persons per year or a rate of 2×10^{-6} cancer fatalities per year. Using the risk factor of 4×10^{-4} fatal cancers per rem for exposures below 10 rem recommended by the BEIR V report[12] and adopted by both ICRP and NCRP, the 2×10^{-6} annual cancer fatality value equates to an annual exposure of about 5 mrem.

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[10] BNFL-5193-SRD-01, Volumes I and II.

[11] *Cancer Facts & Figures - 1996,* American Cancer Society, 1996.

[12] *Health Effects of Exposure to Low Levels of Ionizing Radiation*, BEIR V, Committee on the Biological Effects of Ionizing Radiation, National Academy of Sciences, 1990.

The radiation dose and ALARA design standards proposed by BNFL for the worker, co-located worker, and the public under normal events are shown in Table A of their RESW. These standards for normal operations comply with the limits in applicable laws and regulations. The average risk to the population from the Contractor's facility will likely be significantly less than the limits due to the designed margin of safety and the selection of standards incorporating the application of an ALARA program to optimize exposures from facility operations. For the proposed BNFL facility, airborne effluents are likely to represent the primary pathway for radiation exposure to the public. Applicable regulations restrict the radiation exposure to the public from all airborne effluent sources at the Hanford site, which would include those from the proposed BNFL facility, to ≤ 10 mrem per year. For this reason, the risk to the public from the primary exposure pathway from the BNFL facility will be limited to some fraction of the 10 mrem per year. Such standards are reflected in Table A. The complete standards set proposed by BNFL in its SRD has additional references to ALARA for both worker activities (Safety Criteria 5.2-1, 5.2-2 and 5.2-3) and effluent releases (Safety Criteria 5.2-4, 5.3-2, 5.3-3, 5.3-4, and 5.3-7).[13] Based on an evaluation of the risk to individuals assumed to be located within 10 miles of the controlled area, the BNFL standards set ensures that the risk to the population (public and workers) in the area of the Contractor's facility, of cancer fatalities that might result from normal facility operation and credible accident doses should not exceed one-tenth of one percent (0.1%) of the sum of cancer fatality risks to which members of the U.S. population generally are exposed. Such assurance provides for conformance, in part, to the Operations Risk Goal and for adequate safety during normal operations.

3.3.2 Conformance to the Accident Risk Goal

The Accident Risk Goal (DOE/RL-96-0006, Section 3.1.2) states that: "The risk, to an average individual in the vicinity of the Contractor's facility, of prompt fatalities that might result from an accident should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population generally are exposed." A referenced footnote in DOE/RL-96-0006 states that: "For evaluation purposes, individuals are assumed to be located within one mile of the controlled area." RESW for the worker, co-located worker, and the public, under credible accident conditions, conform to the Accident Risk Goal. The proposed radiation dose standards are not greater than 25 rem for any credible accident. Given that an acute radiation dose of approximately 100 rem carries almost no risk of prompt death,[14] it is reasonable to conclude that a worker radiation dose standard of 100 rem, or less, would satisfy the goal. BNFL has proposed dose standards that are not more than 25% of this value. Based on an evaluation of the risk to individuals assumed to be located within one mile of the controlled area, the BNFL standards set assures that the risk, to an average individual in the vicinity of the Contractor's facility, of prompt fatalities that might result from an accident should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population generally are exposed. Such assurance provides for adequate safety controlling the risk of prompt fatality during credible accident conditions.

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[13] BNFL-5193-SRD-01, Vol. II.

[14] *Method for the Assessment of Worker Safety under Radiological Accident Conditions at Department of Energy Nuclear Facilities*, EH-12-94-01, Vol. 2, *Appendixes*, Appendix B, 1994, p. B-1.

3.3.3 Conformance to the Worker Accident Risk Goal

The Worker Accident Risk Goal (DOE/RL-96-0006, Section 3.1.3) states that: "The risk, to workers in the vicinity of the Contractor's facility, of fatality from radiological exposure that might result from an accident should not be a significant contributor to the overall occupational risk of fatality to workers." A referenced footnote in DOE/RL-96-0006 states that: "For evaluation purposes, workers are assumed to be located within the controlled area."

The radiation dose and ALARA design standards proposed by BNFL in Table A of its RESW for the worker, co-located worker, and the public, under credible accident conditions, conform to the Worker Accident Risk Goal. A radiation dose standard not greater than 25 rem has been proposed for accidents in the unlikely (10^{-4} to 10^{-2} per year) and extremely unlikely (10^{-6} to 10^{-4} per year) event probability ranges. For the unlikely and extremely unlikely events probability range, BNFL has included additional provisions to assure conformance with the Worker Accident Risk Goal. In footnotes to Table A, BNFL states that:

1. "In addition to meeting the listed worker and co-located worker dose standards for accidents, the Worker Accident Risk Goal is satisfied through the calculation of the risk from accidents with accident prevention and mitigation features added as necessary to meet the Goal;" and

2. "In addition to meeting the listed dose standards for accidents, BNFL's approach to accident mitigation is to evaluate accident consequences to ensure that the calculated exposures are far enough below standards to account for uncertainties in the analysis, and to provide for sufficient design margin and operational flexibility."

Conformance with the Worker Accident Risk Goal is evaluated through assessment of the consequence of each postulated accident, as well as the collective risk from all accidents. The proposed 25 rem per event dose standard as a consequence of a single accident is sufficiently low to ensure that the risk to workers and co-located workers from the collective risk of all accidents would likely be acceptable. This assumes the potential number of accidents is limited. This assumption is assured by BNFL's footnotes to Table A, listed above. BNFL's overall approach to accident mitigation and selection of safeguards would provide an adequate level of safety and its proposed consequence limit is sufficiently low to ensure that radiation exposures to workers and co-located workers as a result of accidents would be ALARA. Based on an evaluation of the risk to workers assumed to be located within the controlled area, the BNFL standards set assures that the risk, to workers in the vicinity of the Contractor's facility, of fatality from radiological exposure that might result from an accident should not be a significant contributor to the overall occupational risk of fatality to workers.

The RU review team concluded that BNFL's overall approach to accident mitigation and selection of safeguards could result in a facility with an associated risk of fatality from radiological exposure that is less than that needed to conform to the applicable DOE-specified top-level standards and principles. This extra margin of safety could result in the inclusion of safety systems and components beyond those required for conformance with the top-level standards. However, this would occur only if a single accident were to contribute most of the collective risk for all accidents in the extremely unlikely event probability range. This extra margin can be assessed through an evaluation of an extremely low probability event, such as that of frequency of 10^{-6} per year. The BNFL dose standard of 25 rem per event for extremely unlikely events equates to a risk of fatality per year of 2.5 x 10^{-8}, using the risk factor of 1 x 10^{-3} fatal cancers per rem recommended in the BEIR V report for exposures at or above 10 rem and adopted by both ICRP and NCRP.[15] According to EH-12-94-01, Volume 1, the risk of a fatality to workers in U.S. industries ranges from about 0.3 x 10^{-4} in the "safest" industry to 4 x 10^{-4} in the "least safe" industry. A value of 1 x 10^{-4} can be considered "average." Using 10% as the threshold for a significant contributor as specified in the Worker Accident Risk Goal, an overall risk of fatalities associated with facility accidents of 1 x 10^{-5} per year would result in an accident not being a significant contributor to the overall occupational risk of fatality to workers. This evaluation is consistent with guidance contained in EH-94-12-01, Volume 1. The RU review team concluded that the 2.5 x 10^{-8} fatality per event risk value selected by BNFL is significantly less than the 1 x 10^{-5} value for the risk of fatality per year necessary to conform to the Worker Accident Risk Goal.

3.4 Conformance to the Radiation Protection Objective

The Radiation Protection Objective (DOE/RL-96-0006, Section 3.2) is to: "Ensure that during normal operation radiation exposure within the facility and radiation exposure and environmental impact due to any release of radioactive material from the facility is kept as low as is reasonably achievable (ALARA) and within prescribed limits, and ensure mitigation of the extent of radiation exposure and environmental impact due to accidents."

The radiation dose and ALARA design standards proposed by BNFL in Table A of its RESW for the Worker, co-located worker, and the public conform to the Radiation Protection Objective. The selection of standards incorporating the application of an ALARA program to optimize exposures from facility operations is essential to conforming to this goal. Such standards are reflected in Table A. The complete standards set proposed by BNFL in its SRD includes additional references to ALARA for both worker activities (Safety Criteria 5.2-1, 5.2-2 and 5.2-3) and for effluent releases (Safety Criteria 5.2-4, 5.3-2, 5.3-3, 5.3-4 and 5.3-7).[16]

BNFL's overall approach to accident mitigation and selection of safeguards would provide an adequate level of safety if properly implemented. Furthermore, its proposed consequence limit is sufficiently low to ensure that radiation exposure and environmental impact due to accidents would be mitigated. BNFL has proposed a radiation dose standard of 25 rem for credible accidents in the unlikely (10^{-4} to 10^{-2} per year) and extremely unlikely (10^{-6} to 10^{-4} per year) event probability ranges. For these event probability ranges, BNFL has included an additional provision, namely, to ensure that the calculated exposures are far enough below standards to account for uncertainties in the analysis, and to provide for sufficient design margin and operational flexibility.

3.5 Provisions for Adequate Safety

The overall approach proposed by BNFL for accident mitigation and selection of safeguards would provide for an adequate level of safety if properly implemented. The radiation dose and ALARA design standards proposed in the BNFL RESW support this approach. The selected standards

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[15] *Health Effects of Exposure to Low Levels of Ionizing Radiation*, BEIR V, Committee on the Biological Effects of Ionizing Radiation, National Academy of Sciences, 1990.

[16] BNFL-5193-SRD-01, Vol. II

addressing radiological and nuclear safety are comprehensive and adequate to identify potential safety concerns under normal operations and credible accident conditions.

4.0 Conclusions

The BNFL RESW proposes standards that comply with applicable laws and regulations. The submittal adequately addresses and conforms to the top-level radiological, nuclear, and process safety standards and principles including those contained in Table 1 of DOE/RL-96-0006, the three General Safety Objectives, and the Radiation Protection Objective. The proposed standards limit the risk to workers, co-located workers, and the public from normal operations and accident doses to acceptable levels, require ALARA evaluations during the facility design phase, and ensure mitigation of the radiological impact of accidents. The BNFL RESW would, when implemented, provide for adequate radiological safety.

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